1.1 GENERAL

The Specifications are general and applicable to all the works. The various descriptions and requirements are not necessarily repeated for each separate section of the works; they shall apply to all parts of the works to which they are applicable even where the relevant reference is not made.

1.2 LOCATION OF THE SITE

The New Esna barrage is located 1.2 km downstream of the existing Esna barrage.

The town of Esna is located in Upper Egypt, 50 km upstream of Luxor i.e. 700 km south of Cairo.

1.3 PHYSICAL CONDITIONS

1.3.1 CLIMATICAL CONDITIONS

The town of Esna is located in an arid zone with a tropical desert climate.

Precipitation is low. Heavy rainfalls may occur locally in Upper Egypt on very rare occasions. 5 mm per year can be considered as an average value.

Temperatures at Luxor, 50 km north of the site, varie from 0°C to 48°C. A compilation of the readings from 1975 to 1977 is given hereafter:

TEMPERATURES AT LUXOR
(in centigrades)

	Absolute minimum reading	Mean minimum	Average mean	Mean maximum	Absolute maximum reading
January	0.7	5.0	13.3	22.2	28.2
February	1.0	7.4	16.1	25.4	35.0
March	4.0	10.6	19.8	29.4	39.0
April	8.8	15.0	25.4	34.2	45.2
May	15.5	19.7	29.7	37.1	46.0
June	19.5	22.4	31.9	40.3	48.0
July	20.6	23.5	32.0	40.3	45.2
August	19.8	23.0	31.2	39.5	45.1
September	15.8	20.9	29.5	38.2	43.0
October	11.2	16.9	25.7	34.9	43.0
November	5.2	11.4	20.1	29.4	35.4
December	1.0	6.9	14.8	24.0	31.0

The relative humidity is low throughout the year. The average values in Luxor are:

Average yearly humidity	39%
Average humidity in dampest month (December)	57%
Average humidity in driest month	27%

The general direction of the winds is from the north or north - north-west. Strong sand-laden hot desert winds from the west, the 'Khamsin', however occur from March to early June.

1.3.2 HYDROLOGICAL CONDITIONS

The design flood is fixed at 7 000 m^3/s, i.e. 605 Mm^3/day.

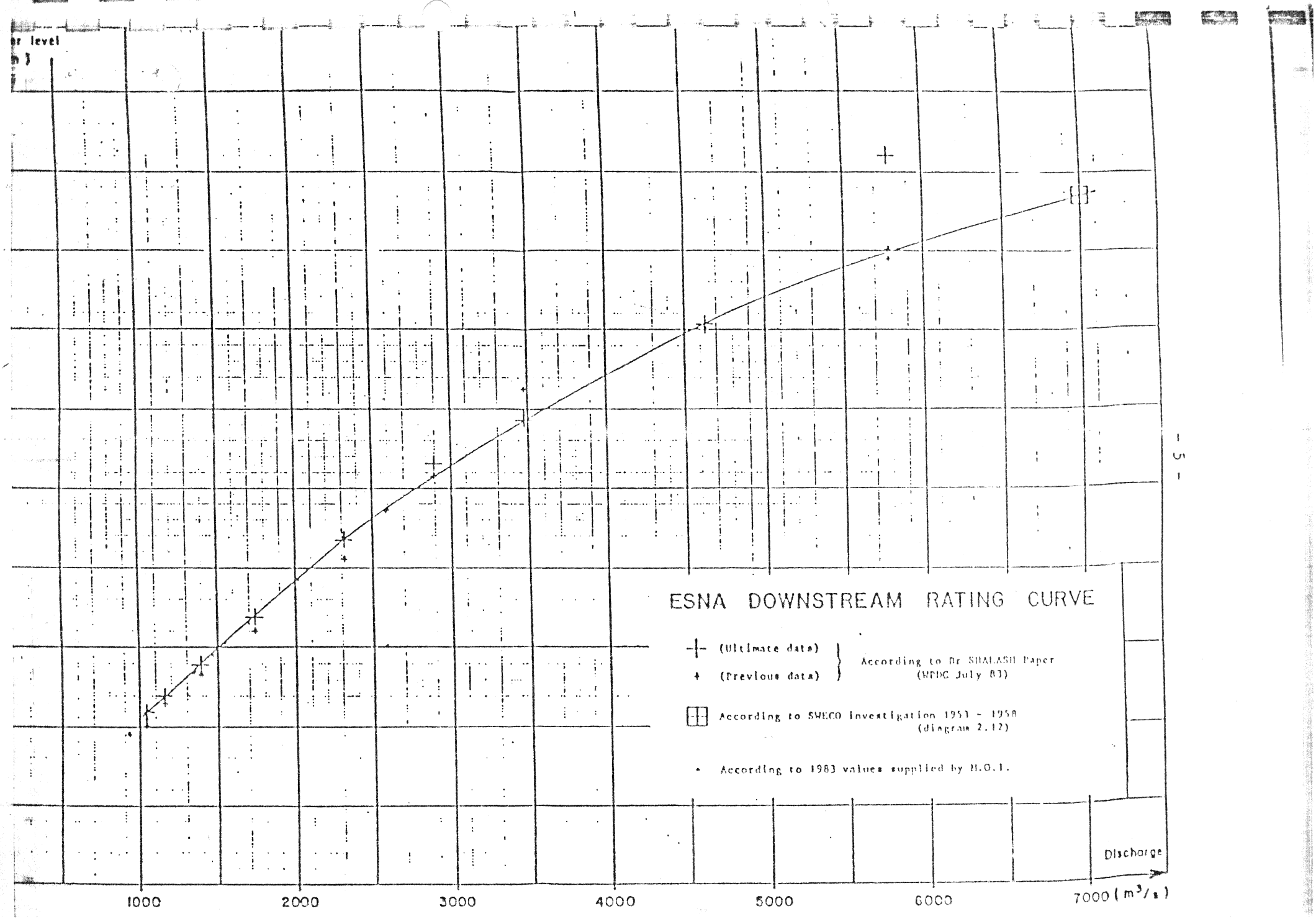
The 1:200 probability flood peak discharge is given as 3 800 m^3/s, i.e. 330 Mm^3/day.

The 1:20 probability flood peak discharge is given as 2 900 m^3/s, i.e. 250 Mm^3/day. This value corresponds to the construction flood.

The yearly average flood is around 2 650 m^3/s, i.e. 230 Mm^3/day. The lowest discharge should not be lower than 800 m^3/s.

However, during the construction of the New Esna, the discharge will have to be generally not less than 1 100 m^3/s in order to cope with navigation requirements through existing Esna lock.

The present water level downstream of the existing Esna barrage is given on the following curve, for discharges varying from 1 000 to 7 000 m^3/s.


er level
h)
ESNA DOWNSTREAM RATING CURVE
(Ultimate data)
(Previous data)
According to Dr SHALASH Paper (WPDC July 83)
According to SWECO Investigation 1953 - 1958 (diagram 2.12)
According to 1983 values supplied by H.O.I.
Discharge
1000
2000
3000
4000
5000
6000
7000 (m³/s)

The mean monthly discharge at Esna is presented in the following table:

Month	Mean monthly discharge (m^3/s)
January	1 000
February	1 520
March	1 460
April	1 470
May	1 980
June	2 440
July	2 580
August	2 200
September	1 580
October	1 320
November	1 350
December	1 070

1.3.3 GEOLOGICAL CONDITIONS

1.3.3.1 General geology

Esna barrage is located on the River Nile some 164 km to north of Aswan Dam. Along its course in Egypt (1 550 km) the Nile receives no tributary. North of Aswan the Nile Valley broadens with flat strips of cultivable land, extending between the river and sandstone cliffs. Near Esna the sandstones give way to limestones.

Along the valley of the Nile, including the Esna area, the following succession of rocks can be found from top of bottom (excluding Pliocene formations and later sediments):

- Thebes formation (hard limestone: 20 m);
- Esna shale (laminated shales: 60 m);
- Chalk (white + marls: 20 m);
- Dakhla shale (laminated shales: 140 m);
- Phosphate formation (hard limestone: 4 m);
- Variegated shales (sandy shales, siltstones: 45 m);
- Nubia sandstones;
- Basement rocks (granites + migmatites).

1.3.3.2 The Esna area

In the Esna area, the Thebes formation is overlain by the lower Pliocene (alternating series of dark grey clay, sandy loam, fine and very fine sand, more rarely cemented to weak sandstones). The top layers are classified as Lower, Middle, Upper Quaternary.

The top layers of the Upper Quaternary include:

- flood plain facies,
- fluvial facies,
- basal horizon.

The flood plain consists mainly of cohesive material (clays and loams) going deep down from the surface. Thickness can exceed 10 m, while minimum thickness is 2-4 m. The cohesive materials overlie medium-grained and fine sands with gravelly soils lying beneath these sands. The river banks consist of sandy loams and fine alluvial sands between clay beds. The geological structure appears complicated when the cohesive materials are encountered in the banks, while the river bottom is composed of sand.

The fluvial facies consists mainly of sands and represents the bed sediment. The study of the grain size distribution of the river bed sediment has demonstrated that the size increases with the depth. The general absence of powdered and clayey fractions is characteristic for their composition.

The basal horizon is encountered at the bottom of the flood plain terrace. It comprises coarse gravelly and more rarely medium-grained polymict sand with some inclusions of well rounded pebbles, igneous and sedimentary rocks.

1.3.4 GEOTECHNICAL CONDITIONS

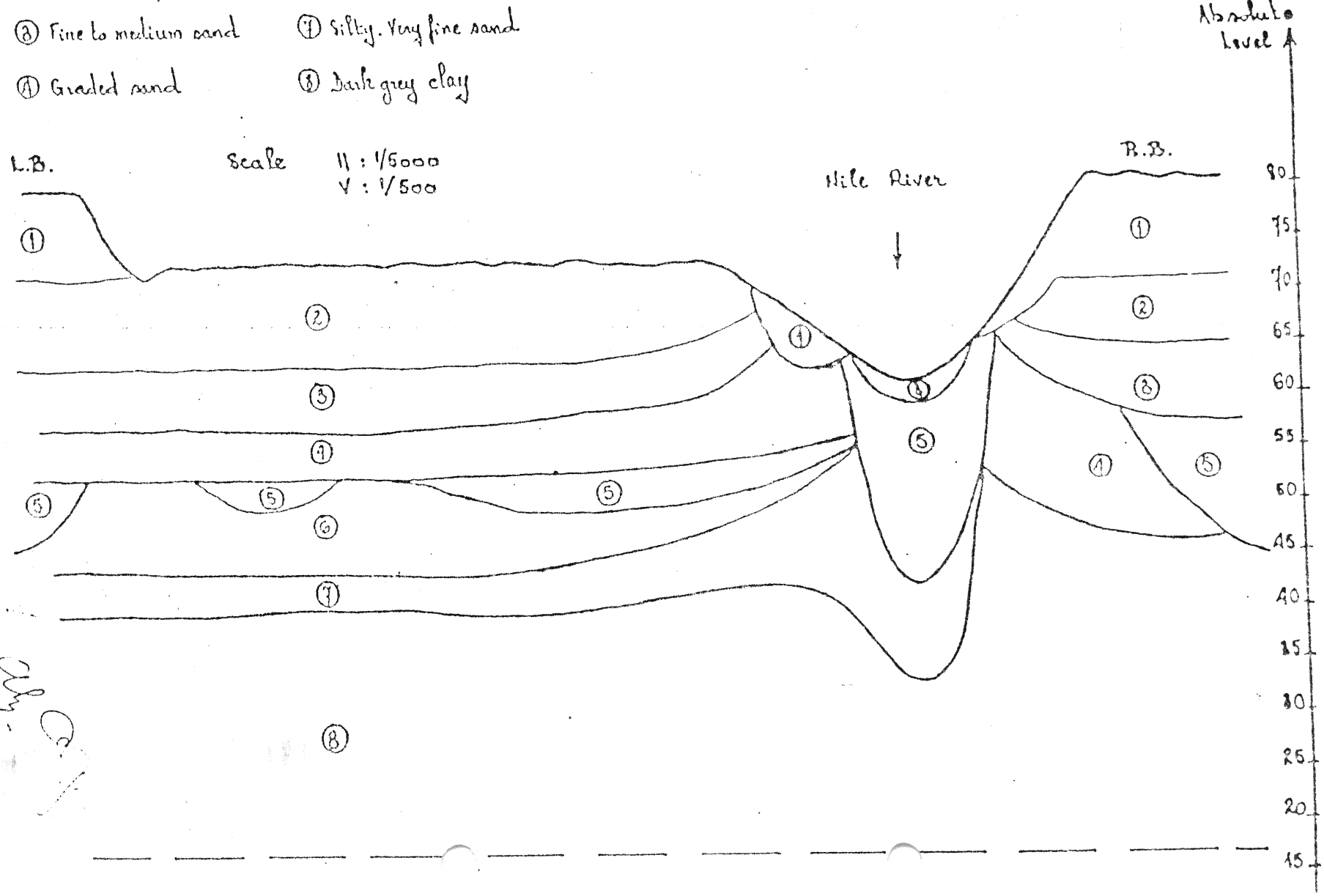
According to the geotechnical investigations carried out in 1978 and 1985, a schematic cross-section has been drawn (see figure hereafter).

From the top to the bottom, the various kind of materials encountered are:

- Loamy sand-silt;
- Fine to very fine sand;
- Fine to medium sand;
- Graded sand;
- Coarse sand and gravels;
- Fine sand;
- Silty-very fine sand;
- Dark grey hard silty clay.

SHEMATIC GEOLOGICAL CROSS SECTION

① Loamy sand. silt
② Fine to very fine sand
③ Fine to medium sand
④ Graded sand
⑤ Coarse sand + Gravels
⑥ Fine sand
⑦ Silty. Very fine sand
⑧ Dark grey clay



The characteristics of each layer have been established mainly from the in-situ testing and correlation charts. The values indicated in the following table are to be used as indicative only.

Final data will be determine according to the findings of additionnal soil investigations to be performed at the beginning of the works.

1.3.5 WATER QUALITY

The water temperature varies from 20°C (March) to 30°C (October).

The mean properties of the Nile water are:

- pH: 7.00;
- Conductivity at 20°C: 0.3 millisiemens;
- Nitrate NO_3 (mg/l): < 0.01;
- Chloride Cl (mg/l): 10
- Sulfate SO_4 (mg/l): 15;
- Hydrogen carbonate HCO_3 (mg/l): 140.

1.4 SITE SERVICING AND TRANSPORT CONDITIONS

The town of Esna can be reached:

- By air via Luxor International Airport, 50 km north to the site.

- By road on the east bank of the Nile river (right bank), with the national highway connecting Cairo to Aswan. The town of Esna, situated on the west bank of the river (left bank) is connected to the right bank through the road over the existing barrage (width of the road: 8 m).

  At the left end of the existing barrage, a movable bridge (turning bridge) over the lock channel has to be opened from time to time, during the passage of the most important boat (existing air clearance under the turning bridge for a downstream water level of 73.00: about 9 m).

Table

PROPOSED DESIGN CRITERIA

Description of soils	γ_d (t/m³)	γ_{sat} (t/m³)	γ_s (t/m³)	D50 (mm)	ϕ_d (°)	Cd (t/m²)	DR (%)	qc (bar)	Rf	k (m/s)	$\gamma_{d\,max}$ (t/m³)
Fine silty sand	1.52	2.00	2.60	0.040	28	-	30 - 55	10 - 30	3 - 7	10^{-5}	1.62
Fine sand	1.60	2.05	2.65	0.15	30	-	40 - 60	10 - 30	2 - 4		1.68
Medium sand	1.63	2.07	2.65	0.35	33	-	45 - 70	20 - 80	2		1.72
Med-coarse sand	1.70	2.10	2.70	2.00	36	-	55 - 80	40 - 120	2	1.6×10^{-3}	1.85
Coarse - very coarse sand	1.50	2.15	2.75	4.00	39	-	55 - 80	> 150	2		2.05
Graded sand	1.70	2.10	2.68	1.50	33	-	50 - 75	40 - 100	2 - 3		1.78
Silty-clay layer*	1.35	1.80	2.54	0.020	21	3				10^{-6} - 10^{-7}	

* The unconfined compressive strength of silty clay can reach 2 MPa.

. By state railway on the east bank of the Nile river. Railway station is located on the alignment of the road over the existing barrage.

. By boat on the Nile river.

1.5 GENERAL DESCRIPTION OF THE PROJECT

The new Esna barrage and power project comprises:

a) A navigation lock

Situated on the left bank, with a useful length of 116 m, width of 17 m and draught of 3 m. The lock is equipped with upstream and downstream mitre gates.

The lock chamber will be filled and emptied by lateral aqueducts and openings at the lock floor level. With these arrangements, the total lock cycle will be around 25 minutes.

The structure consists of blocks which are self-stabilising, even in the event of complete lock emptying with the gates or upstream and downstream stoplogs closed.

The lock is located upstream of the road crossing the Nile via the power plant, spillway and closure dam. This road crosses the lock by means of a bascule bridge.

Boat entry and exit operations are facilitated by upstream and downstream guide walls and by waiting areas.

b) A power plant

The power plant is 92 m long, 59.50 m wide and is divided into three blocks, each including two units separated by expansion joints. An assembly bay for equipment erection is located on the left hand side of the power plant.

The proposed units are of the bulb type with horizontal Kaplan-type turbine runner and horizontal-axis generator totally enclosed in a bulb casing. This casing is located upstream of the turbine runner and submerged in the water stream.

The power plant is of the outdoor type, with two outside gantry cranes for main handling, spanning the power plant from the upstream side to the downstream bulkhead gate grooves.

For erection, the heaviest parts of the units are accessible:

- through the open chamber above the generator casing,
- through the turbine runner pit.

There are six units with a runner diameter of 6.25 m and 16.80 MVA generators. The energy is transferred to the network through a direct 132 kV double circuit overhead line to a new switchgear and after to the existing Esna substation.

The electromechanical equipment for the plant also includes the trash rake, gates, stoplogs and handling equipment, electrical and control/monitoring systems as well as auxiliary mechanical equipment.

c) A spillway

A spillway which maintains the normal pool level at 79.00 m and allows an exceptional flood of 7 000 m^3/s, i.e. 605 Mm^3/day to pass with a maximum upstream level of 79.53 m.

The spillway is separated from the power plant by a dividing pier which channels the water upstream and downstream of the structure.

Its dimensions are: length 173 m and width 35 m. The structure comprises eleven bays equipped with 12 m wide radial gates. The radial gates installed in the outer bays are provided with overspill flap gates to enable floating debris to be disposed of. Expansion joints situated in the piers divide the structure into six blocks.

Each bay is provided with stoplog grooves. The upstream and downstream stoplog sections are handled by the power plant gantry cranes, whose tracks are extended along the entire length of the spillway.

The road bridge situated downstream of the radial gates is supported by the piers, which are extended beyond the centre line of the gate axles.

The main structure, 35 m wide, is extented by a 25 m stilling basi in which most of the energy dissipation downstream of the sill takes place.

d) An earth and rockfill dam

An earth and rockfill dam completes the river closure. This closure dam is therefore located on the right bank in the deepest section of the river, which is currently used for navigation and along which all the river flow will pass during the construction phase. Construction of the closure may be undertaken as soon as the cofferdam is removed and flow diverted over the spillway. This will include, first of all, construction of the closure itself, consisting of a rockfill embankment built on the transition layers. This will be followed by the body of the embankment, consisting of sandy material, obtained mainly at the end of dredging operations.

Finally, protective rip-rap will be placed over the surface of the closure dam, while watertightness of the sandy embankment will be ensured by the construction of a plastic diaphragm wall extending into the foundation layers as far as the impermeable horizon. The plastic diaphragm wall is also extended under the concrete structures (spillway, power plant and lock) to protect them against underseepage.

Moreover, the scheme includes:

- a new switchyard and the connection with the existing substation,
- a road running over the structure and connecting the Cairo-Aswan road on the right bank with the riverside road on the left bank,
- a drainage system for the areas situated between the old and new barrages,
- rip-rap bank protection,
- service buildings and housing,
- navigation facilities on the existing Esna lock, etc.

The Contract concerns the Civil, Electrical and Mechanical works for the new Esna barrage and power project as briefly described hereabove, and includes also:

- the temporary works (cofferdam, dewatering),
- the additional geotechnical investigation and the detailed analysis of the findings,
- the detailed design according to the updated geotechnical data and hydraulic model tests,
- the working drawings for all the civil works and manufactured equipment.

1.6 DRAWINGS SUPPLIED TO THE CONTRACTOR

The Contractor will receive no drawings other than the drawings forming part of the Contract.

The drawings supplied to the Contractor are established for cases of maximum load likely to occur during operation of the Permanent Works, without taking into account temporary load situations which may occur during construction.

The main dimensions of the equipment are given for information only. They are not final. They may be adapted to suit the Manufacturer's methods and designs with approval of the Engineer.

1.7 DESIGN TO BE CARRIED OUT BY THE CONTRACTOR

1.7.1 GENERAL

The Contractor shall be responsible for behaviour of the Permanent Works during the various construction phases. He shall provide for all equipment and accessories and for all working arrangements necessary to limit stresses on the works, so that stability of the structures is not threatened and so that stresses and deformation remain within acceptable limits.

In the context of the above-mentioned arrangements, the Contractor may be authorised by the Engineer to reinforce the design of the Permanent Works, provided always that such authorisation shall not entitle the Contractor to any additional payment, whether on account of the quantity or quality of the materials used in addition.

The Contractor is entirely responsible for the execution of documents (drawings, diagrams, design calculations, etc.) for the different supplies.

For the equipment, a precise list of all drawings, diagrams and design calculations to be submitted to the Engineer, shall be drawn up at the start of the design stage in agreement with the Engineer. However, the Engineer reserves the right to request detailed execution drawings at a later stage in order to facilitate understanding of equipment functions.

1.7.2 DETAILED DESIGN AND CIVIL WORKS WORKING DRAWINGS

The Contractor will have to prepare the Detailed Design and Working Drawings.

1.7.2.1 Detailed design

The Detailed Design will include all the calculation notes justifying the stability and dimensions of the structures, and in particular the calculations of the structure foundations (load bearing capacity, settlement, differential settlement, etc), as well as justification of the soil treatment to be envisaged prior to construction (in the case of the concrete structures) or after construction (for densification of the closure dyke).

1.7.2.2 Working drawings

The Working drawings for all the works covered by the Contract shall be prepared under the Contractor's responsibility.

1.7.3 CIVIL WORKS OVERALL AND DETAIL DRAWINGS RELATED TO EQUIPMENT

The Contractor shall supply the following documents for the Engineer's approval:

- Civil works guide drawings showing the layout and overall dimensions of the equipment, the grouting areas, location of hatches, the clearance dimensions of the equipment, the routings and dimensions of conduits, cable trays and pipework, etc.;
- Drawings of reservations to be made in the concrete with the directions and values of stresses transmitted to the concrete by the equipment;
- Drawings of built-in parts;
- Layout drawings of built-in parts in secondary concrete and pregrouted parts in primary concrete.

1.7.4 OVERALL AND DETAIL DRAWINGS OF THE EQUIPMENT

The Contractor shall supply drawings of assemblies, parts of assemblies and large parts of the equipment to the Engineer for approval.

The Contractor shall also supply all necessary diagrams and sketches, electrical diagrams, oleo-electrical diagrams, etc.

The Contractor shall supply all drawings, notes, diagrams and sketches necessary for the Engineer to assess the following:

- Compliance of the works with the Codes, Standards, Specifications and state of the art;
- Suitability for plant intended used;
- Coordination with civil works;
- Suitability for erection, maintenance and repair.

Immediately after award of the Contract, the Contractor shall propose to the Engineer a complete list of drawings, sketches, diagrams and notes to be submitted to the Engineer. The Engineer will determine those documents to be submitted for approval an those to be transmitted for information.

1.7.5 EQUIPMENT DESIGN CALCULATIONS

The design calculations shall be sent with the drawings; no equipment drawings shall be approved until the Engineer has been provided with the design calculation for that supply. For any item of equipment, partial design calculations may be submitted to the Engineer depending on the various stages of execution of drawings (for example, grouting drawings, built-in parts, structures, operating devices, etc.). A complete set of design calculations containing all the partial calculations for each item of equipment shall be given to the Engineer on completion of the execution drawings for the item of equipment in question.

The Engineer reserves the right, during the design period, to request the Contractor for any additional design calculations which he considers necessary.

1.8 LINES AND REFERENCE LEVELS

At the beginning of the works, the Contractor and the Engineer shall agree on definition and general setting-out of the structures to be built on the site.

This general setting-out shall comprise at least the definition of 2 reference lines and four reference level (bench marks) for the structure to be built. These bench marks will have to be built in places non affected by the works.

The coordinates indicated on the tender drawings are based on the general UTM grid of the Arab Republic of Egypt. The same base is to be used for all the references to be carried out.

The Engineer will draw-up a report to confirm completion of these operations in the field and the Contractor's acceptance of these references.

1.9 STANDARDS CODE REQUIREMENTS AND DESIGN PARAMETERS

1.9.1 STANDARDS

1.9.1.1 Standards to be used

Unless otherwise provided the standards according to which work is to be performed or tested are ASTM standards, wherever these apply.

1.7.5 EQUIPMENT DESIGN CALCULATIONS

The design calculations shall be sent with the drawings; no equipment drawings shall be approved until the Engineer has been provided with the design calculation for that supply. For any item of equipment, partial design calculations may be submitted to the Engineer depending on the various stages of execution of drawings (for example, grouting drawings, built-in parts, structures, operating devices, etc.). A complete set of design calculations containing all the partial calculations for each item of equipment shall be given to the Engineer on completion of the execution drawings for the item of equipment in question.

The Engineer reserves the right, during the design period, to request the Contractor for any additional design calculations which he considers necessary.

1.8 LINES AND REFERENCE LEVELS

At the beginning of the works, the Contractor and the Engineer shall agree on definition and general setting-out of the structures to be built on the site.

This general setting-out shall comprise at least the definition of 2 reference lines and four reference level (bench marks) for the structure to be built. These bench marks will have to be built in places non affected by the works.

The coordinates indicated on the tender drawings are based on the general UTM grid of the Arab Republic of Egypt. The same base is to be used for all the references to be carried out.

The Engineer will draw-up a report to confirm completion of these operations in the field and the Contractor's acceptance of these references.

1.9 STANDARDS CODE REQUIREMENTS AND DESIGN PARAMETERS

1.9.1 STANDARDS

1.9.1.1 Standards to be used

Unless otherwise provided the standards according to which work is to be performed or tested are ASTM standards, wherever these apply.

Where such standards are mentioned, the latest revision or edition at the time of delivery of tenders shall apply. The Engineer may approve the substitution of other equivalent National Standard Specifications provided a statement of the exact nature of the deviation or substitution and complete specifications for the materials to be used are submitted to the Engineer and his written approval obtained before ordering or using the material in the Permanent Works. In referring to standards the following abbreviations have been used:

- ASTM: American Society for Testing and Materials;
- ISO: International Organisation for Standardisation;
- AWS: American Welding Society;
- ACI: American Concrete Institute;
- AFNOR: Association Française de Normalisation;
- AASHTO: American Association of State Highway and Transportation Officials;
- API: American Petroleum Institute;
- AISC: American Institute of Steel Construction;
- EM: Engineer Manual of US Corps of Engineers;
- DIN: Deutches Institut fur Normung;
- ANSI: American National Standards Institute;
- IEC: International Electrotechnical Commission;
- FEM: Fédération Européenne de la Manutention;
- ASME: American Society of Mechanical Equipment;
- SSPC: Steel Structure Painting Council;
- PR: Paraseismic Rules (French Standard);
- DTU: French standards: Document Technique Unifié;
- BS: British Standards;
- ESS: Specifications and Regulations adapted by the Egyptian Standard Specifications and the Ministry of Housing and Public Utilities of A.R.E.

1.9.1.2 Standards to be on site

The Contractor shall obtain and keep on site at least one copy in English of each standard which is referred to in the Specification. These standards shall at all times be available for inspection and use by the Engineer's Representative.

The Contractor shall also follow the stipulations of the law No. 89/1946, updated laws, and other laws concerning the Syndicate of Engineering Professions in the A.R.E.

1.9.2 CODE REQUIREMENT FOR STRUCTURE DESIGN

1.9.2.1 Definition of the structures

a) Superstructures

Structures which are not subjected to submergence, wave action and spray such as bridges, slabs, beams, roofs, stairways, supporting crane and so forth.

b) Power plant structures

These structures are divided into the two following parts:

- Power plant superstructures: Structures which are components of the power plant but not subjected to submergence, wave action and spray, such as bridges, slabs, beams, roofs, stairways, supporting crane and so forth.

- Power plant hydraulic structures: all structures of the power plant which are subjected to submergence, wave action and spray.

c) Hydraulic structures

All structures which are not components of the power plant but are subjected to submergence, wave action and spray, such as barrage, lockwalls, spillway piers, intake and inlet, retaining walls subject to contact with water and so forth.

1.9.2.2 Concrete code

a)	ACI 318-77:	Appendix B, alternate design method, of the Building Code Requirements for Reinforced Concrete.
b)	EM 1110-1-2101:	Working Stresses for Structural Design.
	EM 1110-2-2000:	Standard Practice for Concrete.
	EM 1110-2-2103:	Details of Reinforcement - Hydraulic structures.
	EM 1110-2-3001:	Planning and Design of Hydro-electric Power plant structures.
c)	ESS:	Specifications and Regulations adapted by the Egyptian Standard Specifications and the Ministry of Housing and Public Utilities of A.R.E.

1.9.2.3 Steel code

Manual of steel construction (American Institute of Steel Construction).

ESS: Specifications and Regulations adapted by the Egyptian Standard Specifications and the Ministry of Housing and Public Utilities of A.R.E.

1.9.2.4 Road bridge code

AASHO: American Association of State Highway Officials.

ESS: Specifications and Regulations adapted by the Egyptian Standard Specifications and the Ministry of Housing and Public Utilities of A.R.E.

1.9.3 DESIGN PARAMETERS

1.9.3.1 Design stresses

a) Concrete

- Specified compressive strength of concrete (f'c) at 28 days.

  For the hydraulic structures, including Power Plant hydraulic structures: f'c = 3,000 psi (21 MPa)

. Permissible stresses.

Superstructures: ACI 318-77 - Section B3.

Hydraulic structures: EM 1110-1-2101. § 7. Power Plant structures.

b) Reinforcing steel

. Reinforcing steel shall conform to the provisions of ASTM A615, Grade 60 (yield strength equal to 60 000 psi).

. Permissible stresses:

- Superstructures: ACI 318-77. Section B3;
- Hydraulic structures: EM 1110-1-2101. § 7 and Power Plant structures;
- Temperature and shrinkage reinforcement shall be in accordance with EM 1110-2-2103. Section 10.

c) Structural steel

. Structural steel: ASTM A36, Yield Strength 36 000 psi (252 MPa).

High strength structural steel: ASTM 440, Yield strength 42 000 psi (294 MPa).

. Working stresses.

Working stresses are defined in EM 1110-1-2101. § 8 and AISC..

When the loading includes in addition to Group I loads (see EM 1110-2-2101), any Group II loads, working stresses 33 1/3% greater than specified herein may be used in design of concrete, reinforcing steel and structural steel.

1.9.3.2 Design loads

The following design loads shall be considered in the design.

a) Dead loads

The dead loads considered in the design consist of the weight of the structure itself, of the fixed superstructures and the permanent part of the earth pressure against the wall.

b) Live loads

The following live loads shall be used in the designs:

. Load on backfill: 1000 daN/m²

. Loads on superstructures:

Workshop, unloading platform:	500 daN/m²
Other rooms, not taking into account equipment:	250 daN/m²
Accessible flat roofs:	150 daN/m²
Sloping roofs:	75 daN/m²

. Loads on bridges: live loads on access bridges are defined in accordance with AASHO Specifications (HS 20 - MS 18 Loading class).

. Live loads of travelling cranes and equipment including dynamic effects.

. Wind loads: Buildings and structures will be designed to resist safely a dynamic pressure due to wind in any horizontal direction.

The intensities are as follows:

- $q = 56$ daN/m² in service,

- $q = 98$ daN/m² in exceptional loading.

($q = 1.35 \times \frac{V^2}{16.3}$; 1.35 additional coefficient for open site)

. Seismic loads:

The seismic loads will apply with a horizontal force equal to 0.10 g and a vertical force from bottom to top equal to 0.066 g at the centre of gravity of the structure.

The increase in water pressure will be calculated by the Westergaard formula, the overall effect of which is given by:

$$p = 0.583 \gamma H^2$$

where:

$\gamma = 0.10$ g
H = head of water

In case of earth pressure on the structures the seismic effect shall be considered according to MONONOBE-OKABE's formulae, where:

kh = 0.10
kv = 0.066

. Live loads on Power Plant structures:

The following uniformly distributed live loads shall be used in the design of slabs, beams, girders and columns in the following Power Plant areas:

Roofs	250 daN/m^2
Stairways	500 daN/m^2
Floors:	
- Equipment and storage rooms	1000 daN/m^2
- Control room	1000 daN/m^2
- Generator room	2500 daN/m^2
- Turbine room and erection floor	5000 daN/m^2
- Maintenance shop	1500 daN/m^2
- Transformer room (or deck)	1500 daN/m^2
- Pump room	1000 daN/m^2
- Misc. (offices, toilets, receptions rooms)	500 daN/m^2
Intake deck	5000 daN/m^2
Power plant access	1500 daN/m^2

1.10 MEETINGS

During the works, the Engineer or his representative shall organise, at regular intervals or exceptionally, meetings at the works site or at another suitable place.

The Contractor or his qualified Representative shall participate in all these meetings.

The Employer or his Representative may attend these meetings.

The agenda shall include approval of the minutes of the previous meeting, progress of the works with respect to the schedule and analysis of the difficulties encountered in the works.

The minutes of the meeting drawn up by the Engineer or his Representative shall be deemed after approval by the other participants, to be written confirmation of the declarations, instructions and decisions taken during the meeting.

1.11 SUBMITTALS

1.11.1 PROCEDURE

Except where otherwise stipulated in the Contract, or where different instructions are received from the Engineer, the procedures to be followed shall be as set out in the following paragraphs.

The documents to be submitted shall be supplied to the Engineer at the address specified for notifications in Clause 68.2 of the Conditions of Contract.

The documents shall be in a form approved by the Engineer and shall include identification of the structure, the Contract, the Contractor and sub-contractor or supplier, if applicable, identification of the corresponding drawing and, if applicable, reference to details of the latter and to the corresponding section of the Specifications. A space for the Contractor's and Engineer's approval stamp and initials should be provided.

All documents shall be International Standard size (base A4: 210 x 297 mm).

In the documents submitted for the Engineer's approval the Contractor shall draw attention to any variation with regard to the Contract.

Drawings shall be established according to the ISO Standards (in particular ISO 12).

Each monthly report (as defined in the following specific clause) shall be revised by the Contractor to take into account the Engineer's remarks. It shall then again be submitted after revision.

Where the submission of certain documents is related to progress of the works, their submission shall be according to the programme. Furthermore, different documents pertaining to related clauses shall be submitted in a coordinated manner.

Once the Engineer has examined the submitted documents, the Contractor shall revise them and present them again as requested, identifying any changes made since the last time they were submitted. The Contractor shall distribute copies of the revised documents to all parties concerned, asking them to notify without delay any failure to meet the projected arrangements.

Laboratory

1.11 SUBMITTALS

1.11.1 PROCEDURE

Except where otherwise stipulated in the Contract, or where different instructions are received from the Engineer, the procedures to be followed shall be as set out in the following paragraphs.

The documents to be submitted shall be supplied to the Engineer at the address specified for notifications in Clause 68.2 of the Conditions of Contract.

The documents shall be in a form approved by the Engineer and shall include identification of the structure, the Contract, the Contractor and sub-contractor or supplier, if applicable, identification of the corresponding drawing and, if applicable, reference to details of the latter and to the corresponding section of the Specifications. A space for the Contractor's and Engineer's approval stamp and initials should be provided.

All documents shall be International Standard size (base A4: 210 x 297 mm).

In the documents submitted for the Engineer's approval the Contractor shall draw attention to any variation with regard to the Contract.

Drawings shall be established according to the ISO Standards (in particular ISO 12).

Each monthly report (as defined in the following specific clause) shall be revised by the Contractor to take into account the Engineer's remarks. It shall then again be submitted after revision.

Where the submission of certain documents is related to progress of the works, their submission shall be according to the programme. Furthermore, different documents pertaining to related clauses shall be submitted in a coordinated manner.

Once the Engineer has examined the submitted documents, the Contractor shall revise them and present them again as requested, identifying any changes made since the last time they were submitted. The Contractor shall distribute copies of the revised documents to all parties concerned, asking them to notify without delay any failure to meet the projected arrangements.

1.11.2 PROGRESS REPORT

1.11.2.1 Civil works report

Within a period of 10 days from the end of each month, the Contractor shall submit 20 copies of a monthly report which shall contain at least the following information:

a) the state of progress of the main structures compared with the approved programme;

b) the list of Constructional Plant available on the Site together with the assignment of the said Plant and the quantities of material in site;

c) the list of all personnel employed;

d) a summary of all work carried out during the month in question together with a description of any difficulties or problems occurring therein;

e) a description of the climatic conditions occurring;

f) a description of any claims made by the Contractor during the said month;

g) the situation with respect to payments, together with the dates on which the projected Interim Certificates were presented by the Contractor and on which the said Certificates were approved by the Engineer;

h) photographs.

The format of the document shall be submitted to the Engineer's approval.

1.11.2.2 Electromechanical report

The Contractor shall provide the Engineer with two types of reports of an agreed type as follows:

. Quarterly progress reports of in-works manufacture. These reports shall be supplied in 20 copies 10 days after the end of each quarter up until the date of dispatch of the last supply. These reports shall indicate for each item of supply:

- the state of progress of the execution documents,
- the state of progress of in-works manufacture,
- the dates of in-works tests already carried out during the quarter or planned for the following quarter,
- dispatches planned, in progress or already made during the quarter,
- photographs taken in-works.

. Monthly on-site erection report:

These reports shall be supplied in 20 copies 10 days after the end of each month from the start of erection work. They shall include in all cases:

- the state of progress of customs clearance and local transport operations,
- a report on the supply stored on site,
- a list of Contractor's personnel present on site,
- the state of progress of erection including work executed during the month and the main difficulties encountered,
- the tests in progress or already carried out during the month and those planned for the next month,
- photographs taken during erection.

1.11.3 PHOTOGRAPHS

To record the general progress of the work as well as particular details and special phases of construction, the Contractor shall take photographs at regular intervals.

The photographs of a given part of the works shall always be taken from the same location and with the same angle. The negatives shall be colour negatives not less than 24 x 36 mm in size.

Approximately 3 times the number of required photographs shall be taken by the Contractor out of which a third will be selected by the Engineer for final enlargement.

The procedure shall be as follows:

. 10 days before the end of each month, the Contractor shall furnish 2 proofs (10 x 15 cm) of each view;

. within 2 days the Engineer will select the views to be enlarged;

. 8 enlarged prints (18 x 24 cm) of each selected view shall be supplied with each Monthly Progress Reports.

Three albums of an approved type able to receive the total envisaged prints shall be supplied to the Engineer with the first monthly reports.

The total number of views to be taken shall be about 1 000.

1.11.4 DRAWINGS ESTABLISHED BY THE CONTRACTOR

The Contractor shall submit 5 copies of all drawings, plus those which he needs to be returned. After approval or modification requested by the Engineer, the drawings shall be distributed as requested, in accordance with the terms of the above clause on 'Procedure'.

1.11.5 RAW MATERIALS PROCUREMENT DOCUMENTS

At the request of the Engineer, the Contractor shall supply documents proving acceptance in his workshop of the raw materials required for production of the supply.

The documents shall show the percentage of the tonnage received in relation to the weights given by the Contractor in the tables for each item of equipment.

1.11.6 TESTS AND INSPECTIONS, PROGRAMMES AND PROCEDURES

Within 2 months of the date of entry into force of the Contract, the Contractor shall submit to the Engineer for approval, a summary table of the tests and inspections to be carried out both in the works and on site for each item of equipment.

This table schedule shall include the programme and description of the location where the workshop tests and inspections are to be carried out. It shall show, by means of a distinctive symbol, the tests or inspections at which the Engineer will be present or not, the decision being made previously by common agreement between the Contractor and the Engineer.

The summary table produced for each type of Supply shall make a distinction between:

- raw materials tests and inspections,
- workshop tests and inspections (parts or appliances, sub-assemblies, completed assemblies with blank testing,
- tests and inspections carried out on site (inspections during erection, blank tests, commissioning and taking-over tests).

The detailed procedures for workshop and on-site tests and inspections, which the Contractor intends to use for all equipment, shall be submitted to the Engineer for approval within 2 months before execution of the tests and inspections. These documents shall include:

- the description of the inspection methods,
- test or inspection sheets with dimensions and spaces left blank for entry of the actual values,
- a description of the tests and test platform.

1.11.7 TEST AND INSPECTION DOCUMENTS

For each item of equipment, the Contractor shall:

- provide the Engineer with a complete report of the first stage tests and inspections. This report shall be sent immediately to the Engineer and, in any case, with the inspection request for the second stage test,
- make available to the Engineer all documents necessary for second stage testing,
- submit the final report on tests and inspections carried out to the Engineer for approval.

1.11.8 DISPATCH DOCUMENTS

- Consignment notes:

  The Contractor shall supply consignment notes for each dispatch bearing the reference number of the supply dispatched. These consignment notes shall include details of the content of each crate or package dispatched together with the identification numbers of each package, the dimensions net and gross weights and where necessary, any special indications regarding storage and the type of packaging.

- Auxiliary dispatch documents:

  The type, number and addresses of the auxiliary documents shall be defined in good time with the agreement of the Engineer.

1.11.9 ERECTION AND DISMANTLING DOCUMENTS

The Contractor shall supply the erection block diagrams and where necessary, dismantling diagrams, of the various supplies covered by the Contract in the form of manuals. These documents shall include all information and sketches necessary for a proper understanding of initial erection together with any disassembly and reassembly operations required for maintenance, in particular:

- the use of erection platforms with overall dimensions sketch,
- lifting facilities required,
- details of the sequence of operations,
- erection clearances and tolerances.

1.11.10 INFORMATION CONCERNING MATERIALS (as defined hereafter)

The Contractor shall indicate the products, models, options and other information concerned in each manual and shall complete the standard information provided by suppliers by information specific to the works. The Contractor shall attach the manufacturer's instructions for installation or use wherever the Specifications so demand. The Contractor shall supply the copies which he requires plus 3 which will remain with the Engineer and, where necessary, the Employer.

1.11.11 SAMPLES

Samples (mock-ups) shall be submitted to the Engineer's approval one month before the date by which the Contractor must proceed with construction or place the corresponding order.

The Contractor shall submit samples with all accessories necessary for operation and attachment and shall coordinate the submission of samples concerning work which is aesthetically or physically interlinked.

The Contractor shall identify each sample, which shall be accompanied by documents describing its constitution, its operation and its assembly or method of fixing.

The Contractor shall submit the specified number of samples, and in all cases one specimen shall remain available to the Engineer.

1.11.12 PROGRAMME

In addition to the general programme which he is required to submit in accordance with clause 14 of the Conditions of Contract, the Contractor shall draw up and submit to the Engineer a detailed quarterly works programme. This quarterly programme shall be accompanied, if necessary, by a corrected version of the general programme.

All programmes shall be in conformity with the overall schedule entitled 'Programme for coordination of tasks on site relating to different Contracts'. They shall be submitted to the Engineer in 5 copies.

1.11.13 SECURITY PLAN

The Contractor shall submit to the Engineer, within a period of one month from the order to start the Works, the security and sanitary plan applicable to the whole of the Site. This plan, drawn up to ensure security as regards the main risks facing the personnel, will indicate:

- the measures provided for to this effect, both in defining the construction methods and during the various phases of the Works; it will specify in particular, in accordance with the construction methods and plant used, the precautions to be taken concerning on the one hand the risk of personnel or materials falling, on the other hand the vertical and horizontal movements of constructional plant,

- the measures provided for in respect of first aid to the injured in accidents and to the sick,

- the measures contributing to hygienic working conditions and especially the consistency and quality of the premises for personnel.

The Contractor shall make available a First Aid Station on site (120 m^2 approximately).

The security and sanitary plan shall be updated by the Contractor, who shall indicate any modifications to the Engineer.

1.12 QUALITY OF MATERIALS

1.12.1 GENERAL

Unless otherwise provided for in the Contract, all materials, fixtures, fittings and supplies furnished (hereafter called 'materials') shall be new and of standard first-grade quality. All work of assembly and construction shall be done in a neat and workmanlike manner. Materials shall be free of defects and imperfections.

The whole of the materials and workmanships of the Works, both temporary and permanent, shall be in accordance with the Contract as to character, type, construction, constituent substances, quality, weight, strength, shape and dimensions, etc.

1.12.2 PURCHASE OF MATERIALS, SAMPLING AND TESTING FOR APPROVAL

In asking for prices of materials intended for delivery to the site and incorporation in the Works, the Contractor shall provide the manufacturer or supplier with complete information as may, in any case, be necessary to secure compliance with the Contract and, in every case, he shall quote the above clauses in fall to each such manufacturer or supplier.

Prior to procurement, the Contractor shall furnish to the Engineer, for his approval, the names of the manufacturers of all equipment and materials which he contemplates incorporating in the Works. The Contractor shall also furnish such pertinent information as to capacities, efficiencies and sizes, and such other information as may be required by the Engineer.

Samples of materials shall be submitted to the Engineer for approval when so directed. In addition the Engineer shall be entitled to demand that tests, as he may think fit before approval, shall be carried out in laboratories nominated by him. Notwithstanding the provisions of the Conditions of Contract, the cost of supplying samples and testing of materials shall be deemed to be included in the Bill of Quantities.

Materials, installed or used without the Engineer's approval shall be under risk if subsequent rejection.

1.12.3 PLACE OF PREPARATION OF MATERIALS - INSPECTION

To allow possible inspection of materials in the course of or on completion of preparation or manufacture, the Contractor shall give the Engineer written notice of the workshops and places where the materials are manufactured or stored and advise him of the state of progress, so that the inspection may take place at appropriate times and without delaying the despatch of materials to the site.

1.12.4 TRANSPORT AND STORAGE OF MATERIALS

Packaging

- Packaging shall be of the maritime type.
- The Contractor shall take all necessary precautions to pack the supply in such a way that it remains undamaged. Spare parts shall be packed separately.
- Each package shall bear a colour identification symbol for the site clearly painted in such a way that the final destination of the part is easily identified on site. These special identification marks shall be added in addition to the normal marks used for transport.
- The net and gross weights of large parts and the gross weights of crates shall be painted in clearly legible figures on the packages before dispatch from the production workshops.

Transport - Handling

The Contractor shall acquaint himself in detail with the conditions of loading, transport and off-loading. He shall be responsible for all off-loading operations including on-site and the bringing of supplies from their place of storage on site to their final destination.

Storage on site

The Contractor shall take all necessary measures to store any supplies or parts of equipment which cannot be installed directly in their final location. Two months before the arrival of the first supplies on site, the Contractor shall submit to the Engineer for approval a plan of the warehouses and installations he intends to install on the area placed at his disposal for the storage of the supplies together with the arrangements for security, handling and storage of the supply.

Only external type parts such as galvanised structural steel work, gates, etc. may be stored on a yard. The rest of the supplies such as electrical equipment, winches, etc. must be stored in closed buildings away from dust and humidity.

The Contractor shall provide air conditioned stores for such equipment which needs to be kept at certain temperature and humidity.

All stores shall be delivered equipped to the Employer in good condition after repair at the completion of the job.

As the supply arrives on site, the Contractor shall provide the Engineer with a list of this supply indicating its place of storage.

1.12.5 GUARANTEE AND OTHER OBLIGATIONS OF THE CONTRACTOR RELATIVE TO MATERIALS

The Contractor shall guarantee the strength and quality of all materials and workmanship.

Consequently, he shall execute or order to be executed at his cost his own tests on samples of materials and construction work, and shall give the Engineer written notice of the results of such tests. The Engineer may, but is not obliged to, approve materials and construction work on the evidence of such tests.

The Contractor shall not be relieved of his obligations with respect to the sufficiency of the materials, workmanship and works by reason of no objection having been taken thereto by the Engineer during the progress of the operations although the same may have been inspected by him. The Contractor shall, when required by the Engineer, furnish all information as to quality, weight, constituent substances, dimensions, levels, strength and description of the materials and give the Engineer such other particulars as may be required.

1.13 QUALITY CONTROL - TESTING

1.13.1 GENERAL

The Contractor shall execute in workshop and on site all the tests mentioned below:

- Raw materials tests and inspections.
- Workshop tests and inspections:
  - parts or appliances,
  - sub-assemblies,
  - finished assemblies with blank tests.
- Site tests and inspections:
  - tests and inspections during and/or on completion of erection,
  - taking over tests,
  - end of Defects Liability Period tests where appropriate.

Inspections and tests shall be carried out in two stages:

- First stage tests and inspections carried out by the Contractor for his own purposes.
- Second stage tests and inspections carried out, when necessary, in the presence of the Engineer at the written request of the Contractor. This request shall be accompanied by a first stage test and inspection report.

1.13.2 RAW MATERIALS TESTS AND INSPECTIONS

Mechanical, chemical, radioscopic, etc. certificates of tests carried out in accordance with standards shall be required for all materials used in the manufacture of the equipment. These certificates shall be supplied to the Engineer with the workshop inspection request.

1.13.3 WORKSHOP TESTS AND INSPECTIONS

Each finished item of equipment and supply shall be assembled and inspected by the Engineer. The Contractor shall inform the Engineer, in writing, of the date and the place at which the equipment may be inspected one month in advance. The Engineer shall notify the Contractor 8 days in advance, of his intention to proceed with the inspection. If the Engineer does not inspect within 10 days of the date indicated by the Contractor, the Contractor may proceed with the tests and inspections which will then be considered as having been carried out in the presence of the Engineer.

For workshop tests and inspections of certain items of supply which does not require the presence of the Engineer, tests and inspections will be carried out in one stage only by the Contractor.

For simple items of supply the Contractor will only be asked to guarantee conformity with supply to standard specifications.

The first stage tests and inspections report shall include:

- Certificate of conformity with Contract Specifications of the supply or part of the supply concerned;
- X-rays: places at which X-rays were taken and interpretation;
- Ultrasonic: reports and interpretation;
- Dye penetration, video-recordings: reports and interpretation;
- Dimensional inspections using sketches specified previously;
- Hydraulic tests: reports and interpretation;
- Performances: reports and interpretation;
- For standard products: type test certificates.

The Contractor shall make the following documents available to the Engineer during the second stage tests and inspections:

- X-rays films;
- Raw materials: chemical analyses and mechanical test certificates;
- Electrodes: test certificates for batches;
- Welders: qualification certificates;
- Welds: certificates of tests carried out on samples and welding procedures;
- Description and type of packaging used.

Following receipt of the documents in question and following any second stage tests and inspections required and provided that the results of these tests and inspections are satisfactory, the Engineer shall draw up and hand over to the Contractor the 'workshop inspection certificate' for each item of supply. The Contractor will then be able to proceed with the painting, packaging and dispatch to site operations of the supply concerned by the 'workshop inspection certificate'.

1.13.4 TESTS AND INSPECTIONS BEFORE CONCRETING

As erection proceeds and before grouting into concrete, the erection shall be inspected at the request of the Contractor. Provided that the results of the inspection are satisfactory, the Engineer shall notify suitability for grouting or concreting.

1.13.5 TESTS ON COMPLETION

The tests on completion shall comprise the following stages:

a) Blank tests

These tests include the 'dry' tests (for hydro-mechanical equipment) and/or 'on stop' tests (for rotating machines) and/or 'de-energised' tests (for electrical equipment). They shall be carried out as soon as possible after the end of erection.

b) Commissioning tests

These tests include the 'wet' tests and/or 'start up' tests and/or 'energised' tests. They are carried out once all the conditions required for such tests are met (both for the equipment tested and for the other equipment and works concerned by these tests). Following commissioning tests and if the results of these tests are satisfactory, the Engineer will deliver a Certificate of Suitability for Operation.

c) Postcommissioning operation period

This postcommissioning operation period starts after delivery of the Certificate of Suitability for Operation. It is used to check correct operation of the whole of the Supply. The minimum duration of this period shall be 400 hours operation or 2 calendar months for a Supply which cannot achieve 400 hours for reasons for which the Contractor is not responsible.

d) Taking over tests (acceptance tests)

These tests are operating tests carried out under normal operating conditions for checking the characteristics and/or contractual guarantees of each equipment. The Contractor shall carry out these tests during the Postcommissioning Operation Period.

1.14 LABORATORY

1.14.1 GENERAL

The Contractor shall, within 3 months of commencement of the works, provide, equip and maintain the site laboratory on land made available to this effect (Contractor Camp Area).

This time allowed shall be shortened if the programme of works requires use of the laboratory at an earlier time.

The Works include:

- construction of the building,
- supply of equipment (which shall include at least the items of equipment listen hereafter) and furniture,
- maintenance,
- servicing including the supply of water, electricity, chemicals and all consumable materials required for correct implementation of the tests.

On completion of the works, the laboratory and its equipment shall remain the Contractor's property.

The laboratory may be used by the Contractor, the Employer and the Engineer, under the Engineer's management.

The staff supplied by the Contractor shall work under the orders of the Engineer.

1.14.2 TESTS TO BE PERFORMED

The laboratory shall be equipped to perform the following main tests:

- Identification of soils;
- Compaction tests for soils;
- Relative density determination for soils;
- Measurement of soil permeability;
- Measurement of mechanical properties of soil;
- Particle size analysis of soil and of concrete aggregates;
- Concrete analysis;
- Concrete workability;
- Checking of concrete strength (compression, tensile strength by Brazilian test);

. Cement: setting time, Blaine fineness, heat of hydration, strength;

. Design and checking of grout and concrete for diaphragm walls;

. Design and checking of bituminous material.

1.14.3 BUILDINGS

The laboratory building shall comprise:

. 1 general entrance hall accommodating a van;

. 1 area for preparation of materials;

. 1 room reserved for concrete tests;

. 1 room reserved for soil and road materials tests;

. 1 room with floor area of 6 m^2 with saturated and air-conditioned atmosphere at 20°C or a 6 m^3 tank with controlled temperature at 20°C for conservation of the concrete samples;

. 1 room air-conditioned at 20°C for tests requiring such a temperature condition (cement tests for example);

. 2 furnished 12 m^2 offices (one reserved for the Engineer's Representative, the other for the Contractor's Representative).

The whole building shall cover a minimum area of 100 m^2.

The building shall also have:

. toilets,

. running hot and cold water,

. temperature air conditioning.

1.14.4 EQUIPMENT

1.14.4.1 Concrete and grout section

a) Cement

. 1 Vicat apparatus;

. 6 Le Chatelier needle moulds;

. 1 Le Chatelier needle mould kettle;

. 1 Blaine permeability meter;

. 3 vacuum jar calorimeter for measuring the hydratation heat of cement by means of semi-adisbatic calorimetry (Langavant method);

. 1 mortar mixer (Rilem Cembureau method);

. 1 mould compacting machine in accordance with AFNOR NFP 15.412;

. 4 three-sample moulds 4 x 4 x 16 cm;

. 1 automatic flexure testing machine with scales of 1200 N and 6000 N;

. 1 mortar workability meter LCPC (Laboratoire Central des Ponts et Chaussées - France).

b) Aggregate

. 1 set of 250 mm diameter sieves (from 0.080 to 80 mm);

. 1 giratory sieve shaker allowing sifting by wet process;

. 1 sand equivalent test set;

. 1 speedy sand moisture tester.

c) Concrete

. 1 125 litre concrete mixer (vertical axis);

. 4 Abrams cones with frames;

. 1 concrete aerometer;

. 1 LCL (Laboratoire Central des Ponts et Chaussées - Lesage) concrete workability meter;

. 6 concrete thermometers;

. 18 cylindrical moulds 16 x 32 cm;

. 18 cylindrical moulds 25 x 50 cm;

. 1 3000 KN field compression tester with pumping unit and class B pressure gauge (AFNOR);

. 1 caping set for 16 x 32 cm cylindrical specimens;

. 1 caping set for 25 x 50 cm cylindrical specimens;

. 2 rap-act plasticity meter;

. 2 Schmidt concrete hammer;

. 1 pachometer;

d) Grout

. 2 standard Marsh cones for viscosity measurements;

. 1 compression device for strength and modulus determination;

. 1 baroid equipment for filtering measurements;

. 1 equipment for direct mud and grout density measurement;

. 2 sieves 80 µ;

. 1 vane test equipment.

e) Miscellaneous

. 2 25 mm dia vibrators (immersion type);

. 1 600 l electric oven with thermostat;

. 1 15 l microwave oven;

. 1 120 g balance, 0.005 g precision;

. 1 2000 g balance, 0.1 g precision;

. 1 15 kg automatic balance, 5 g precision;

. 1 100 kg automatic balance, 10 g precision;

. 1 caliper square;

. 2 hygrothermographs;

. 1 spare gauge for concrete tester;

. 1 press calibrating dynamometer;

. 1 core drilling machine (up to 16 cm core diameter);

. 1 Los Angeles machine or dynamical crushing test apparatus.

1.14.4.2 Section soil

a) Laboratory

. 4 sets of 250 mm dia sieves from 0.080 mm to 80 mm;

. 1 giratory sieve shaker allowing sieving by wet process;

. 2 extra sieves 0.080 mm and 0.40 mm;

. 2 static cone penetrometers for liquid limit;

. 1 Casagrande liquid limit apparatus;

. 1 plastic limit set;

. 1 set for hydrometer test;

. 1 conductimeter;

. 1 rotary shaker for 6 bottles;

. 1 200 g balance, 0.010 g precision;

. 5 compaction Proctor moulds;

. 2 CBR mould;

. 2 standard compaction hammers;

. 2 modified compaction hammer;

. 1 5 kg balance, 1 g precision;

. 1 15 kg balance, 5 g precision;

. 1 set for permeability test on Proctor mould;

. 1 complete set for relative density determination of soils (ASTM D2049) with 2 spare moulds.

. 3 oedometer equipments complete with loading frame and measuring equipment;

. 50 thin walled laboratory samplers Ø 38 mm;

. 1 compression device for unconfined compressive strength determination allowing measurements of unconfined compressive strength up to 25 kg/cm^2;

. 1 complete triaxial equipment with compression equipment.

b) Site

. 3 density apparatus rubber baloon type with piston;

. 2 cutting edges for Proctor mould;

. 1 nuclear density moisture meter.

1.14.5 LABORATORY TRANSPORT

The Contractor shall provide for the exclusive use of the laboratory a new four-wheel-drive vehicle able to transport the equipment for the on-site tests and the samples to be sent to the laboratory as well as the personnel for tests.

1.14.6 RECORD BOOKS OF RESULTS

The sheets recording test results shall be of a type approved by the Engineer. The Records Book of tests and results shall be kept by the Contractor. A copy of the Records Book shall be supplied once a month to the Engineer's Representative.

1.15 SUPPLY OF WATER AND ELECTRICITY

The Contractor shall supply water on the site including drinking water and electricity in the quantities required for the Works, for the use of staff and workers as well as for the needs of the Employer and the Engineer.

1.16 TELEPHONE AND TELEX

The Contractor shall supply telephone and telex facilities at work site and in its Cairo office.

1.17 TEMPORARY SANITARY FACILITIES

For all buildings on the site, waste water shall be treated. The treatment installation shall include:

- a two compartment grease separator for domestic waste water,
- a sceptic tank,
- a bacterial plate.

The whole site shall be kept clean and tidy. All refuse shall be deposited in an area specially provided for this purpose and then covered with 50 cm of earth on completion of the works.

1.18 MAINTENANCE OF EXISTING SERVICES

The Contractor shall avoid or provide for diversion of such services as the following, so as to ensure that such public services are not interrupted:

- roads and tracks,
- irrigation structures,
- drainage canals,
- navigation channel.

More especially, the Contractor will build a temporary road on the left bank as shown on drawing NE-01 to divert the present road which crosses the Contractor camp area.

Concerning navigation conditions during the works, the Contractor shall take all dispositions to ensure that no interruption of the traffic occur either during the phase where the cofferdam is in place on the left hand side of the river, or during the closure dam execution.

The Contractor shall ensure the necessary coordination with the authorities concerned.

The Contractor shall inform the Engineer one month in advance of any work anticipated to take place in the vicinity of public services.

1.19 WATER CONTROL AND PROTECTION AGAINST NATURAL PHENOMENA

1.19.1 GENERAL RESPONSIBILITIES OF THE CONTRACTOR

Without prejudice to other stipulations in the Contract, all constraints related to the presence of or risks caused by water, all additional work which may prove necessary on this account, all damage caused by water, all pumping and all structures not mentioned in the Contract which the Contractor may find he has to build for water control purposes shall be at the expense of the Contractor.

The Contractor shall be responsible for all damage caused to the foundations or the structures or any part of the Works and occasioned by floods, sheet water or runoff or by failure of any part of the diversion or protection works carried out by the Contractor. Any repairs that are necessary will be carried out at his own expense.

1.19.2 PROTECTION AGAINST NATURAL PHENOMENA

The Contractor shall protect the Works against any damage which may result from:

- flood flows,
- wind,
- storm,

and shall adapt the programme of works in order to minimise the risks. The protection works carried out by the Contractor may incorporate existing flow channels and structures, but must not in any way affect the efficiency of these systems, whether upstream or downstream of the site.

Before any works are begun, the Contractor shall submit to the Engineer's approval the methods he proposes to apply in order to protect the Works, unless these are imposed by the design incorporated in the Contract.

Unless other arrangements are proposed by the Contractor and accepted by the Engineer, the Contractor is responsible for protecting the site in accordance with the general arrangement presented in Division 3.

The Contractor shall construct and maintain all cofferdams, diversion canals and other temporary dissipation and protection structures. As soon as these structures are no longer required, they shall be demolished so as not to impede commissioning of the Works or natural stream flow.

1.20 PUBLICITY

All publicity on the site is prohibited. This prohibition does not apply to signs indicating the name of the Contractor, the nature of the works in progress and the various organisations concerned.

Four signs indicating the nature of the works, the Employer, the Engineer, the Contractor and other organisations concerned, on a format and in a location defined by the Employer, shall be erected by the Contractor.

1.21 OFFICES AND HOUSING FOR THE ENGINEER AND EMPLOYER

1.21.1 GENERAL

The Contractor shall build, equip and maintain offices and houses for the exclusive use of the Engineer or the Employer. These buildings shall be made available within a period of 6 months from the date of the order to start the Works (please refer to Clause 1.21.3.b)).

The Contract includes:

- construction of the buildings,
- supply of office furniture and equipment (including at least the equipment listed hereafter),
- supply of water and electricity,
- repair or replacement of equipment or furniture that is no longer in working condition.

For the offices, the Contract includes maintenance, including daily cleaning, the supply of consumable products (paper, pencils, etc), small office equipment (staplers, scissors, etc).

On completion of the Works, the furnished buildings shall remain the Employer's property.

However they shall be handed over to the Employer after good repair and redecoration for his permanent use.

1.21.2 BUILDINGS FOR OFFICE

The buildings shall be located close to the Contractor's site office and shall comprise:

- 1 drawing office and meeting room covering 30 m^2 each,
- 3 offices each covering 20 m^2,
- 15 offices covering 15 m^2,
- 1 room for storing materials and equipment, covering 15 m^2.

These offices may be located in:

- 1 building with the drawing office, 2 20 m^2 offices and 10 15 m^2 offices,
- 1 building with the meeting room, 1 20 m^2 office and 5 15 m^2 offices.

The building shall also have:

- toilets,
- a shower,
- running hot and cold water,
- lighting,
- air conditioning.

Equipment:

- 24 desks, 160 x 90 cm,
- 1 table for meetings, 160 x 500 cm,
- 24 office armchairs,
- 20 ordinary chairs,
- 25 office cabinets with a unit volume of 800 dm^2,
- 4 drawing table, 175 x 100 cm, fully equipped, including a suitable light,
- 1 vertical cabinet for storing drawings,
- 2 electric typewriter with correcting ribbon,
- 1 photocopying machine allowing reduction from A3 to A4 size,
- 1 dyeline drawing reproduction machine,
- 1 computer IBM PC with printer,
- 1 set of shelves in the 12 m^2 equipment store room, designed for a load of 1 kPa,
- 1 refrigerator, capacity 150 litres.

Moreover, the Contractor shall make available to the Engineer, on the site, photocopying and drawing reproduction machines.

1.21.3 HOUSING FOR EMPLOYER AND ENGINEER

The houses for Engineer and Employer Staff shall be located on an area of land made available for this purpose (see drawing NE-01).

a) The housing is divided into 3 types:

. House type 1 for bachelor: minimum area 70 m^2 with:

- one living room,
- one kitchen,
- one bedroom,
- one bathroom and toilets.

. House type 2 for a family, minimum area 100 m^2 with:

- one living room,
- one kitchen,
- 3 bedrooms,
- one bathroom and toilets.

. House type 3, minimum area 140 m^2 with:

- one living room,
- one kitchen,
- 4 bedrooms,
- 2 bathrooms and toilets.

b) The number of houses shall be:

b1) Type 1: 4
Type 2: 9
Type 3: 7
} to be made available within a period of 6 months from the order to start the works.

b2) Plus the following:

Type 1: 4
Type 2: 9
Type 3: 7
} to be made available within a period of 12 months from the order to start the works.

b3) In addition to the following:

100 low cost units in multistore buildings (the area of each unit not less than 80 m^2).

The specifications of which should be submitted by the Contractor for the approval of the Employer and the Engineer prior to the begining of work.

They should be made available according to the following order:

- the first 20 units after 9 Abdelghani months from the order to commence the work,
- the second 20 units after 12 months from the order to commence the work,
- the remaining 60 units after 24 months from the order to commence the work.

1.21.3.b3) is an item up to the Employer's option.

This clause should be inserted separately in the 'Bill of Quantity and Schedules' (volume III), page BQ 28 and not to be included in item No. 101 (offices, housing and services to Employer and Engineer) page BQ 3.

b1, 2, 3 are subject to the penalties in Clause 47(1) 'Special conditions'.

c) The houses under b1 & b2 shall be air conditioned and similar to the ones used by the Contractor's staff and shall include at least tables, armchairs, chairs, beds, bedding, cupboards, commode, cookers, sinks, refrigerator, bathroom fittings (~~air conditioning will be for houses under b1, b2 only~~).

d) During the execution of works the facilities provided by the Contractor (such as restaurants, shops, sparetimes facilities) shall be available to the Employer's and Engineer's staff in the same condition as for the Contractor's staff.

1.22 SERVICES PROVIDED FOR THE ENGINEER AND EMPLOYER

1.22.1 TRANSPORT

The Contractor shall make available to the Employer for his own use in the context of the Works the following vehicles:

- 3 cars, minimum 75 HP, for 5 people;
- 3 4-wheel-drive cars, minimum 90 HP, for 4 people; 87 abdelghani
- 12 site cars, minimum 50 HP, for 4 people; 48 abdelghani
- 3 site pick-ups, minimum 75 HP;
- 2 microbus at least 14 passengers each;

- 2 minibus at least 20 passengers each;
- 1 bus at least 40 passengers;
- 2 ambulance vehicles having a carrying capacity of at least two stretchers each and provided with all accessorie;
- 2 survey boats equipped with inboard 6 HP engine, including all necessary auxiliary equipment and tools.

The exact number may vary according to the real requirements, which shall be notified by the Employer.

The vehicles shall be new and of a type and model approved by the Engineer.

They shall be made available according to a programme determined by the Engineer. The first vehicles shall be made available within one month following the order to start the Works.

The Contract includes:

- supply of the vehicles,
- replacement of any vehicle which is no longer in working condition or no longer offers adequate safety; all vehicles which have run up a total distance of 100 000 km shall be replaced at the Engineer's request,
- maintenance, including supply of spare parts and supply of fuel, lubricants and other consumables,
- supply of the services of one driver.

All vehicles shall be covered by a 'comprehensive risk' insurance policy.

Vehicles that are replaced or which the Engineer no longer needs shall be returned to the Contractor; all vehicles shall be returned at the latest at the end of the Period of Maintenance.

All the equipment, instruments and vehicles mentioned in the Contract to be used by the Engineer are to be as well available for use by the Employer.

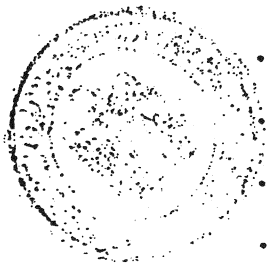
1.22.2 ASSISTANCE

The Contractor shall provide the assistance and personnel which may be required by the Engineer's Representative in relation to preparation of the daily statements and works supervision, such as messengers, staff holders, watchmen, etc, whether required permanently or on an occasional basis.

1.22.3 TOPOGRAPHICAL EQUIPMENT

The Contractor shall make available to the Engineer, for his own use, the following instruments:

- 1 theodolites of the WILD T2 type, with DI4L equipment,
- 2 automatic levels of the Zeiss Ni 2 type,
- 4 folding 4 m staffs with incorporated level,
- 3 tripods,
- 2 50 m steel ribbons,
- 2 20 m steel ribbons,
- 3 10 m steel ribbons,
- 2 1.5 m straight rules,



rods, topographer's sunshades, wood and steel stakes, cord and other accessories necessary for topographical and dimensional verification operations.

These instruments, made available within one month following the order to start the Works, shall be new, and in case of damage, they shall be repaired or replaced immediately on the Engineer's request.

On delivery of the Certificate of Completion, the Contractor shall dispose of the equipment.

1.22.4 MEDICAL ATTENDANCE

The Contractor shall at all times maintain adequate first aid attendance on the site. A fully qualified first aid man shall be immediately available on the site at all times when work is in progress. In addition the Contractor shall make necessary arrangements with a qualified doctor to be called to the site when required for routine or emergency consultation.

Adequate and approved equipment and facilities, including transport shall be provided by the Contractor (two ambulance cars should be always available in site).

Arrangements shall also be made by the Contractor with nearest suitable hospital for the acceptance of urgent cases of sickness or injury.

Arrangements made regarding first aid and medical attendance shall be subject to the approval of the Medical Officer of Health and the Engineer.

1.23 CONTRACT CLOSEOUT

Without prejudice to the other operations specified in the Contract or which reasonably follow therefrom, the Contractor shall proceed with the following operations:

1.23.1 DEMONSTRATION OF OPERATION

- Before delivery of the Certificate of Completion, the Contractor shall demonstrate to the Engineer and the Employer the operation of each installation.
- He shall also instruct the Employer's personnel in operation, adjustment and maintenance of the installations, on the basis of the Supplier's operating instructions.

1.23.2 CLEARANCE OF SITE ON COMPLETION

After having cleared away and removed from the site all Constructional Plant and Temporary Works, the Contractor shall restore the whole of the site to a clean and tidy condition. This restoration will involve removing all projections of concrete foundation structures, metal parts, etc.

With due consideration to the visual aspect of the completed Works, the Engineer may accept that the Contractor covers the foundation structures with a layer of earth at least 0.50 m thick. Whether the structures concerned are removed or covered with earth, the Contractor shall adjust the land form, with finishing by leveller, following the Engineer's indications.

1.23.3 OPERATION AND MAINTENANCE MANUAL

1.23.3.1 General

The manuals shall give all information on operation, maintenance and dismantling of the equipment.

1.23.3.2 Procedure

The Contractor shall submit to the Engineer 3 copies of each manual in draft form.

On receipt of the Engineer's written approval of the submitted draft, the Contractor shall supply 23 copies of the final edition of each instruction manual to the Employer and 2 copies to the Engineer.

The final editions of all manuals shall have identical bindings. The binding shall take the form of rigid Pegamoid, and on the spine shall appear the name of the equipment concerned according to the order of supply. The maximum format authorised for bindings shall be 24 x 32 cm, for a maximum thickness of 8 cm. These shall conform in every respect to the approved draft.

1.23.3.3 Miscellaneous

a) Technical brochures of the type produced for commercial purposes and which contain the required information may be used entirely or in part.

b) Drawings, diagrams, images or photographs shall be used where this will facilitate understanding and improve clarity.

c) Precautions and warnings concerning safety of personnel and of the equipment shall be set out.

d) Division into sections:

The various sections of the manual shall be arranged in the following order:

- Title page;
- Contents;
- Section I - Operation;
- Section II - Maintenance;
- Section III - Dismantling of parts;
- Corresponding publications;
- Drawings in perspective, scale drawings, diagrams, etc.

1.23.3.4 Section I - Operation

This section shall comprise:

a) Detailed description of the equipment.

b) Instructions for starting up:

These instructions will indicate, in order, the operations to be performed to start up the equipment. The precautions to be taken and critical points to be observed shall be highlighted. These instructions shall be given under the following sub-headings:

- Initial starting up;
- Normal starting up;
- Starting up after maintenance.

c) Operating instructions:

These will specify the precautions to be taken and critical points to be observed, and will recommend a method enabling indications to be read periodically and an operating log-book to be established.

A table will indicate possible operating difficulties, with in each case the possible causes and remedial action required.

d) Instructions for shut-down:

These will indicate in order the operations to be performed to stop operating the equipment.

The precautions to be taken and critical points to be observed shall be highlighted. These instructions shall be given under the following sub-headings: 'Normal shut-down' and 'Emergency shut-down'.

e) Characteristic data:

Installed capacity or power rating, voltage, amperage, pressure, temperature, revolutions per minute, discharge, etc.

f) Curves:

The characteristic curves shall be supplied where specified or where it is normal practice to supply such curves with the equipment concerned.

1.23.3.5 Section II - Maintenance

This section shall comprise:

a) Dismantling instructions:

These shall specify the procedure to be followed, operation by operation. Special indications shall be given where exceptional care or precautions are to be taken.

b) Maintenance instructions:

These shall include the preventive maintenance instructions and information on the lubrication required. Programmes shall be presented indicating the intervals at which operation must be interrupted and the checks to be performed after the various periods of operation. A rough description and identification of the special tools required will form part of these instructions.

c) Adjustments - Clearances:

Information shall be supplied in the form of tables concerning adjustment of instruments, alarm and shut-down signals, operating clearances and adjustments necessary for correct operation. This information shall include, also in tabular form, operating conditions such as temperature, pressure, discharge, etc.

The above characteristics must be set out under two sub-headings, 'Recommended' and 'Effective'. The effective characteristics must be taken into account after installation or tests on site.

1.23.3.6 Section III - Dismantling of parts

The instructions shall contain all information necessary for ordering spare parts, such as name and reference number of the part, serial number of the manufactured equipment, etc. Any special arrangements for storing or handling certain parts must also be noted.

oOo

Division 2

GEOTECHNICAL INVESTIGATIONS

2.1 GENERAL

2.1.1 AIM OF THE INVESTIGATIONS

The aim of the geotechnical investigation is:

- to define the elevation of the top of the hard clay layer along the cofferdam axis,
- to bring additional informations on structures foundations soils, especially in the lock area, in order to make a final decision for the soil treatments,
- to bring more details on subsoil compressibility so as to allow a more detailed evaluation of excavation bottom heave, construction settlements and delayed settlements of the structures,
- to define the elevation of the top of the hard clay layer in the axis of the permanent diaphragm wall under structures.

2.1.2 WORKS TO BE CARRIED OUT

The works covered in this division consist of furnishing all labour, material, equipment, facilities and supplies necessary to drill boreholes with continuous coring for undisturbed sampling, to perform Standard Penetration Tests (SPT), to perform static Cone Penetration Tests (CPT) to perform pressuremeter tests and to perform laboratory tests. The works will also include the preparation of a final geotechnical report giving the soil characteristics to be considered for detailed design.

2.2 QUALITY CONTROL

Only specialist Contractors in site investigation and laboratory testing with at least 15 years experience of the same type of works can be approved by the Engineer.

The supervision of field work and laboratory work will be performed by a knowledgeable specialist Consulting Engineer to be proposed by the Contractor to the approval of the Engineer. This specialist Consulting Engineer will prepare the final geotechnical report and will assist the Contractor for the preparation of detailed design in the field of earthworks, foundation engineering and soil treatments.

The Engineer shall be involved in the different stages of the geotechnical investigations. Nevertheless the Contractor should not begin the design of foundation and soil treatment unless he receives the approval of the Engineer on the geotechnical final report (the program of work in Clause 14, volume I, which is up to the approval of the Engineer and Employer, should include clearly the period of time designated for the soil investigations.

2.3 STANDARDS

Unless otherwise provided, the standards under which works are to be performed are:

- ASTM: American Society for Testing and Materials;
- US Bureau of Reclamation: earth manual.

2.4 SETTING OUT

All boreholes, SPT, CPT and pressuremeter tests will be levelled and located with reference to the site benchmarks (see clause 1.8 of Division 1).

2.5 BORINGS, SAMPLING AND IN SITU TESTING

2.5.1 GENERAL

a) A distinction will be made between borings with continuous coring and destructive borings for Standard Penetration Tests, pressuremeter tests, piezometer installation or predrilled holes in case of premature refusals with cone penetration equipment.

b) All boreholes which penetrated into the hard clay layer will be filled with a bentonite/cement mix using a stinger. The proportion of cement, bentonite and water will be such that an unconfined compressive strength of 0.4 to 0.6 MPa be achieved at 28 days.

2.5.2 BOREHOLES WITH CONTINUOUS CORING

The type of boring required in this section is rotary drilling under bentonitic mud in large diameter with continuous coring carried out with a double tube core barrel with use of casings if necessary in top soils.

Each drill hole shall be of diameter such as to allow undisturbed sampling minimum 76 mm diameter till the bottom of the borehole.

The rig strength shall be adequate for the casing weight. No compensation will be paid for abandonned casing.

In order to obtain a good quality continuous sampling, the Contractor should vary the boring technics (rotation speed, pressure on sampler, type of drilling fluid and pressure) according to soil type.

In all cases, the boring water level must at any time be higher than the water table elevation.

The core recovery ratio must be on an average 90% this being evaluated for every 10 m section.

Cores obtained from continuous coring shall be immediately and carefully placed in a clean and dry timber box with a hinged lid especially prepared for this purpose. For each borehole, the cores shall be arranged in the box in the order of their successive extraction. The depth of the cores shall be regularly marked on the box along the alignment of the cores. Places of undisturbed samples shall be filled by wooden spacers indicating that undisturbed samples have been taken. The lids of each core box shall bear the borehole number, the depth, a serial number and the date. The core boxes shall be carefully stored and protected from sun, rain, wind, etc.

Photographs of the core boxes will be taken by the Contractor for each borehole.

Depth of boreholes

- 6 boreholes (2 under structures and 4 along cofferdam axis) will be drilled down to el. -10 i.e. a depth of the order of 85 m;

- For the other boreholes the maximum depth will be of the order of 50 m.

2.5.3 BOREHOLES WITH DESTRUCTIVE DRILLING

Boring performed by destructive drilling for SPT will be of a sufficient diameter to allow if required by the Engineer isolated undisturbed sampling in a minimum diameter of 76 mm till the bottom of the hole.

Although no core recovery is performed in the destructive drilling, a log of the borehole is required based on cuttings examination and SPT samples.

In boreholes devoted to pressuremeter tests, no undisturbed sampling will be required and the borehole diameter will be adapted to the diameter of the pressuremeter probe.

2.5.4 UNDISTURBED SAMPLING FOR LABORATORY TESTING

2.5.4.1 Methods of obtaining undisturbed samples in silty and clayey soils

(1) Selected pieces of the core may be directly extracted from the double tube core barrel during operations of continuous sampling. These samples will be carefully scrapped to eliminate peripheric disturbed material, waxed and secured against mot in a special adjusted case (water resistant).

(2) Samples may be taken with a thin walled sampler statically driven or hammered (Shelby type).

(3) Samples may be directly cased with a double or triple tube core barrel (Pitcher, Mazier, TIR, etc.).

2.5.4.2 Methods of obtaining undisturbed samples in sandy soils

Sampler shall be thin-walled fixed piston drive sampler or compressed air sampler or approved equivalent.

The different sampling methods will be tested and possibly improved during drilling of the first borings with continuous coring.

A special care is required during extraction and handling operations.

Continuous sampling (and possible casing) shall be stopped 25 mm above the top of each undisturbed sample and any disturbed soil cleaned from the bottom of the hole before undisturbed sampling. Extraction of the tube containing the sample shall be carried out carefully without any shocks.

Undisturbed samples shall be trimmed back about 12 mm at the bottom end and all loose materials removed at the top end. Both ends of each sample will be carefully cleaned and sealed in the tube by successive coats of wax applied by brush to a minimum thickness of 8 mm. Top and bottom of samples will be clearly indicated. Each sample shall bear a label mentioning the boring number, the depths of sampling, the type of sampling (with number of blows, weight and fall head of the hammer in case of percussion sampling), the date and a simplified description of the sample (only top and bottom when it is directly cased).

In case where a thin walled sampler is used, tubes shall be true, free form rust and clean. Each sample tube shall be fitted with unworn core cutter having a ratio not exceeding 27% and affording inside and outside clearances to the sample tube less than 2% of the inside diameter. It is important than each drilling assembly include tubes of varying clearances so that the proper clearance may be used for each of the soil types encountered.

In all cases, particular attention shall be given to the non return valve at the sampling head to ensure that the valve shall have large orifice and light spring and shall be inspected before each use to make sure that it is clean and working freely.

Until the samples are dispatched, the Contractor shall be responsible for their safe storage and protection from atmospheric conditions (particularly dessication). Samples will be sent as soon as possible to the soil laboratory in charge of the tests within one week.

2.5.5 SUBMITTALS

The Contractor shall keep a daily record of drilling operations, two copies of which will be handed over to the Engineer's Representative. The record shall include the following informations:

- Contract, Employer, Engineer and Contractor's name.
- Supervisor's name.
- Type of drilling equipment used.
- Location of the hole and level of ground surface with respect to the provided datum.
- Hole number.
- Diameter and depth of all casing.
- Date and weather conditions.
- Ground water levels:
  - at first encountered,
  - before commencing operations in the morning,
  - at completion of operations in the evening.
- Depth of each stratum change.
- Thickness of stratum.
- Elevation of each stratum with respect to the provided datum.
- Description of each stratum, each element of the description having a fixed position within the overall description:
  a) consistency or relative density,
  b) fabric (if appropriate),
  c) colour,
  d) subsidiary constituents,
  e) grading of principal soil type (if appropriate),

f) PRINCIPAL SOIL TYPE (in capital),

g) more detailed comments on constituents or fabric,

h) (geological origine) (in bracket, optional),

i) soil classification symbols.

Example:

Loose yellowish brown silty fine SAND with scattered gravel SM.
(a) (c) (d) (e) (f) (g) (i)

- Position and length of undisturbed samples (top and bottom).

- Position and results of in situ tests carried out.

- Remarks on breakdowns, delays, difficulties.

2.5.6 STANDARD PENETRATION TEST

2.5.6.1 Work included

Standard Penetration Test shall be carried out in all strata from which undisturbed samples cannot be recovered. The frequency of the test will be generally every 1,5 m in the selected borehole, or as directed by the Engineer.

2.5.6.2 Standard

Standard Penetration Test shall be carried out following the procedure designation E21 of the USBR Earth Manual and in accordance with ASTM Standard D 1586.

2.5.6.3 Execution

Extreme care must be exercised in obtaining an accurate 762 mm free fall condition during the test.

Care should also be taken in the measurement to ensure that the test is made just below the bottom of the casing and to guard against sand rising up into the casing due to out-of-balance water pressure.

On no account shall SPT be carried out with the water level in the casing below that of the ground water level.

2.5.6.4 Disturbed samples

All SPT disturbed samples shall be put in airtight bottles or in double plastic bags.

2.5.7 STATIC PENETROMETER TEST

2.5.7.1 Work included

Deep continuous friction-cone sounding at the locations given by the Engineer's Representative. The maximum depth of sounding shall be 35 m.

2.5.7.2 Reference

Static penetrometer test shall be carried out following the ASTM D3441 Standard: 'Deep, quasi static, cone and friction-cone penetration tests of soil' and with the recommendations of the International Society for Soil Mechanics and Foundation Engineering's Report of the Sub-Committee on the Penetration Test for Use in Europe (1977).

2.5.7.3 Equipment

The penetrometer shall be a friction-cone penetrometer such as the Gouda Dutch cone (or similar). The minimum thrust capability of the machine shall be 18 (Eighteen) metric tons with hydraulic piston. The Contractor will ballast or anchor the penetrometer in order to develop a minimum reaction force of 18 metric tons.

The friction sleeve will be of the Begeman type or equivalent allowing measurement of local side friction on a mantle.

2.5.7.4 Execution

During the test, necessary measurements will be performed and recorded to allow determination of:

- tip resistance,
- local side friction measured on the friction sleeve.

The execution of the test shall be in accordance with ASTM. A maxi rate of depth penetration of 1.5 to 2 cm/s shall be maintained at all times.

The Engineer's Representative may require to reduce the rate of penetration according to the site conditions.

If premature refusal is obtained, the Engineer may require the performance of a predrilled hole, the Cone Penetration Test being then performed in this predrilled hole.

2.5.7.5 Submittals

The report of each friction-cone sounding shall include a superposed graph:

- the variation of cone tip resistance (qc) v.s. depth,
- the friction resistance (fs) and the friction ratio (rf) v.s. depth.

The operator shall record on the test sheet at least:

- type of penetrometer tip,
- type of thrust machine,
- date of sounding,
- sounding number,
- location coordinates,
- soil and water elevations.

2.5.7.6 Calibrations

A calibration of the measuring equipment will be performed by the Contractor before the CPT campaign under the supervision of the Engineer.

2.5.8 PRESSUREMETER TEST

2.5.8.1 Standard

Boring hole, inserting the probe, calibrating and testing procedure shall be in accordance with the instructions of the Manufacturer of the pressuremeter and with the "Mode opératoire du laboratoire des Ponts-et-Chaussées (Paris) : Essai pressiométrique normal".

2.5.8.2 Submittals

The Contractor shall supply the results in a superposed graph of:

- Corrected volumetric expansion as a function of pressure (pressuremeter curve).

- Volume change between 30 and 60 s readings for each pressure as a function of the pressure (creep curve).

- Soil profile giving in addition to the elements required in § 2.5.5, variations of (pl-po) and pressuremeter modulus with depth with:

  - pl: limit pressure,

  - po: total horizontal stress.

2.5.8.3 Equipment

The pressuremeter shall be from a well known Manufacturer such as Menard GA. The measuring cell shall be approximately 80 mm diameter and 500 mm long.

2.5.8.4 Execution

Pressuremeter shall be carried out in a hole specially drilled for this purpose (no undisturbed sampling).

The loading test shall be performed up to failure with 10 pressure increments.

At each pressure increment, volume readings shall be taken at 15, 30 and 60 seconds.

2.5.9 PERMEABILITY TESTS

2.5.9.1 Work included

Permeability tests shall be carried out in some of the boreholes, in the hard clay layer as directed by the Engineer's Representative.

2.5.9.2 Reference

Permeability tests shall be carried out following the procedure designation E18 of the USBR Earth Manual.

Tests with variable head (falling head and using head) will also be performed. The height of the tested area in the clay layer will be 5 m.

2.5.9.3 Submittals

For each test the following data shall be provided:

- date of test, number of hole,
- the ground level and top of casing level from which measurement of depth is carried out,
- the bottom level of the borehole and the bottom level of the casing,
- the casing diameter,
- the initial water level before beginning of the test and after the test,
- the table of values of measured water levels versus time,
- the interpretation in terms of equivalent permeability.

2.5.10 PIEZOMETER

2.5.10.1 Work included

Boreholes, as required by the Engineer's Representative, shall be equipped as piezometer.

2.5.10.2 Product

Pierometer shall be made of galvanised metal or plastic pipes with the upper part protected by a larger steel pipe.

Minimum inside diameter of the pipe shall be 45 mm. The bottom shall be provided with slot 1 mm thick forming a screen. The screen length shall be 5 meters unless otherwise prescribed.

Cement bentonite grout shall be mixed in 1:1 proportion and shall be as stiff as compatible with tremie pipe placement.

Sand filter shall pass 3.15 mm sieve and be retained on 1.6 mm sieve.

2.5.10.3 Execution

The level of the screen will be specified by the Engineer. The hole from the bottom to 2 meters below the screen and from 2 meters above the screen to 7 meters shall be grouted. The position of the upper surface of the grout shall be measured by a metal disc attached to light rods or wires.

The space between the screen and the wall of the borehole on the length of screen plus 2 meters below and above shall be filled with coarse sand filter.

The part above the upper grout shall be backfilled except the last 50 cm which shall be concreted. The top of the tubing shall be protected by a 10 cm diameter steel pipe set in the concrete and closed by a lockable ventilated cover.

After completion the piezometer shall be cleaned by airlift until clean water emerges.

2.6 LABORATORY TESTING

2.6.1 GENERAL

A brief description of each sample shall be done.

Soil mechanics tests shall be carried out on samples selected by the Engineer's Representative and the specialist consulting engineer. When receiving 'undisturbed samples', the laboratory must make sure that samples have been correctly cored and that they can be validly considered as undisturbed.

The selection of tests to be performed on the samples will be defined by the specialist consulting engineer and subjected to the agreement of the Engineer. Tests to be performed on mix of samples will be defined in a second stage after obtaining index tests results.

2.6.2 DISTURBED SAMPLES (SPT, disturbed samples and poor quality 'undisturbed samples')

The tests to be performed are index tests including:

- natural water content if required,
- grain-size analysis (hydrometer if necessary),
- Atterberg limits.

On a few number of selected samples or mixture of samples of same characteristics, representative of the different strata encountered the following test shall be performed :

- relative density (when applicable),
- sand equivalent,
- moisture density relation with 2 compaction energies:

Description	Compaction energy	Standard
Standard Proctor	600 kJ/m³	D 698
Specified AASHO Proctor	2700 kJ/m³	D 1557

ASTM D1557 will be used to define maximum density of sands with too large a fine content for relative density determinations.

2.6.3 UNDISTURBED SAMPLES

The tests to be performed are described hereafter:

2.6.3.1 Index properties

All the undisturbed samples will be subjected to a visual description in the laboratory.

Index test include natural water content, dry density, specific gravity, grain-size analysis with hydrometer test if necessary, Atterberg limits, chemical tests (organic and sulfate contents) if required. Minimum/ maximum density on mixtures of undisturbed samples will also be performed. In that case a grading analysis will be performed on the mix.

After performing the index test, the sample will be classified according to the USCS soil classification system.

2.6.3.2 Shear strength

- Undrained shear strength measurement with laboratory vane.

- Unconfined Compression Test (UCT).

  The laboratory test results to be included in the report will give the unconfined compressive strength, the moisture content and the dry density.

- Unconsolidated undrained triaxial tests (UU).

  The laboratory test results to be included in the report will give initial dry density and moisture content, deviatoric stress $(\sigma_1 - \sigma_3)$ versus strain, Mohr circles, resulting undrained friction angle and cohesion intercept.

- Consolidated undrained triaxial tests saturated under back pressure with pore pressure measurement (CU + u).

  The laboratory test results to be included in the report will give initial dry density and moisture content, dry densities and moisture content at the end of consolidation stage, rate of shearing, deviatoric stress $(\sigma_1 - \sigma_3)$ and pore pressure versus strain during undrained shearing, effective stress path (p/q diagram), total and effective stress Mohr circles, interpreted effective friction angle and cohesion intercept.

- Consolidated drained triaxial tests saturated under back pressure with volume change measurement (CD).

  The laboratory test results to be included in the report will give initial, consolidated stage and final dry density and moisture content, deviatoric stress $(\sigma_1 - \sigma_3)$ and volume variations versus strain, rate of shearing, effective stress Mohr circles and calculated drained friction angle and cohesion intercept.

2.6.3.3 Compressibility (one-dimensional consolidation oedometer)

The oedometer tests will yield the usual compressibility characteristics: pre-consolidation pressure, compression index, swelling index, over-consolidation ratio.

For hard clays, the loading will be performed by steps until 3.2 MN/m^2 vertical stress. Unloading will be performed in at least 4 steps in order to allow a good evaluation of unloading characteristics.

The load consolidation curves shall show the void ratio versus vertical stress on a logarithmic scale.

Some oedometer tests shall be carried out with increments of loads and conditions of situation defined by the Engineer in order to simulate the conditions of construction of the structures.

Tests will be carried out on specimen 70 mm diameter and 20 mm thick.

Initial dry density and moisture content will be given for all samples devoted to compressibility test.

2.6.3.4 Dynamic triaxial test

a) Cyclic triaxial test on undisturbed sand samples

These tests will be performed in order to make an appraisal of the liquefaction potential of sands. Samples will be reconsolidated under back pressure and then subjected to cyclic loading.

For each sample the tests will yield the following elements:

- The number of cycles to liquefaction Nl versus shear stress ratio;
- The dynamic modulus versus distorsion;
- The damping ratio versus distorsion;
- The mobilisation of pore pressure versus N/Nl (with N: Nb of cycles).

The dynamic triaxial testing program on sands will be linked to minimum/maximum density testing performed during index testing.

In addition to individual tests results, summary graphs gathering the results obtained for the different samples will be presented.

In case of major difficulties to prepare undisturbed samples and after agreement of the Engineer, some tests could be performed on samples reconstituted to the in situ relative density.

b) Dynamic triaxial test on undisturbed clay samples

Samples will be reconsolidated under a mean effective stress corresponding to the mean in situ stress.

The undrained dynamic stage will be performed by applying series of 5 cycles at different shear stresses . Necessary measurements will be performed in order to allow determination of:

- G/Cu versus distorsion,
- damping ratio versus distorsion,

with:

- G: dynamic shear modulus,
- Cu: undrained shear strength.

After dynamic stage, a final static undrained shearing with pore pressure measurement will be performed.

In addition to individual results, summary graphs giving G/Cu and damping versus distorsion for the different samples will be presented.

2.6.4 STANDARDS

Test	ASTM Standard test method
Moisture content of soils	D 2216
Density of soils in place (dry unit weight)	D 2937
Specific gravity of soils	D 854
Liquid limit of soils	D 423
Plastic limit of soils	D 424
Particle size analysis of soils	D 422
Relative density of cohesion less soils	D 2049
Moisture density relations of soils	D 698 - D 1557
Unconfined compressive strength of cohesive soil	D 2166
Direct shear test of soils under consolidated drained conditions	D 3080
Unconsolidated undrained strength of cohesive soil in triaxial compression	D 2850
One-dimensional consolidation test	D 2435
Sand equivalent	D 2419

2.6.5 LABORATORY TESTING REPORT

A detailed laboratory testing report will be presented. In addition to the test results, it will include a critical appraisal of the different results, summary tables giving the different properties measured on the samples, extreme values, mean values and recommended design parameters for the different layers and, if necessary, the different structures.

2.7 FINAL REPORT

In addition to the submittals required for borings, in situ testing and laboratory testing, the Contractor will submit a final report including:

- Geotechnical profiles for the different structures giving on the same drawing: simplified borelogs with laboratory pertinent information such as fine content and fine plasticity, etc., pressuremeter limit pressure and modulus variations versus depth, CPT profiling and SPT results versus depth. Proposed site stratigraphy will be shown on these profiles.

- Synthetic drawings giving grading curves of the sands encountered in the different site areas.

- A4 graphs showing the variations of blow count versus depth, tip resistance versus depth, relative density versus depth, undrained shear strength of hard clays versus depth and any other graph necessary for the selection of design parameters. These graphs will be presented for the lock area, the spillway area, the power plant area, the closure dam area and the whole site.

. Maps showing the elevation of the hard clay layer for the whole site, extent of areas which might be susceptible to liquefy, and any other map which might facilitate the general understanding of the site.

. A critical discussion based on in situ results, laboratory results and recent geotechnical litterature leading to the recommendation of geotechnical parameters for detailed design with respect to:

- settlement calculations,
- stability analysis,
- dynamic analysis including liquefaction risk.

This report will be submitted one month after the end of the site investigation but drafts of the soil profiles will be prepared and presented to the Engineer immediately at the end of the site investigation.

The report dealing with the engineering consequences (soil treatment, settlements with respect to construction schedule, stability analysis and dynamic analysis) will be considered and paid as part of the detailed design documents.

oOo

Division 3

TEMPORARY COFFERDAM AND DEWATERING

3.1 TEMPORARY COFFERDAM

3.1.1 GENERAL

- The Contractor will take all necessary steps to protect the works being constructed under this contract against the 2,900 m^3/s construction flood (associated water level 75.30).
- Any damage to the works or delay to their operations resulting from lack of protection against the construction flood or lack of maintenance of the cofferdam will be corrected by the Contractor and will not constitute a basis for claims for additional payment or extension of time.
- The Contractor will check that the excavations he performs inside or outside the cofferdam do not endanger the local and general stability of the cofferdam.
- All parts of the cofferdam common with final embankments will be treated as permanent structures.

3.1.2 GEOMETRY

3.1.2.1 Layout

The layout of the temporary cofferdam is given in drawing NE-06. The layout in the horizontal plane is imposed for the section equipped with protections type I.

The layout of the remaining part can be modified by the Contractor but for payment purposes the layout shown in drawing NE-06 will be considered.

3.1.2.2 Cross section and slope protections

The cofferdam cross section and slope protections are defined in drawing NE-06. The cofferdam crest is at el 75.50 in order to protect the construction site against the 2,900 m^3/s construction flood.

3.1.3 EMBANKMENT MATERIAL AND COMPACTION

Embankment material will be a sandy material coming from areas to be excavated (§ 5.3.5.2 b). The embankment volume located between cofferdam slope protections and cofferdam axis as shown in drawing NE-06 will be compacted to the 70% DR requirement of § 5.3.6.3.

3.1.4 DEMOLITION

After having served their purpose, all cofferdams and other protective works not included in the final embankment will be demolished and sent to spoil bank or levelled and graded as directed by the Engineer so as not to interfere in any way with the operation or usefulness of the completed works.

3.2 TEMPORARY DIAPHRAGM WALL AND EXCAVATION DEWATERING

3.2.1 GENERAL

The construction of the lock, guide walls, power plant, spillway intermediate caissons and retaining walls will be performed in a dewatered excavation. Due to the large permeability of the Nile sands, direct dewatering of the excavation cannot be performed without the construction of a temporary diaphragm wall socketed the low permeability hard clay layer encountered below the sand a gravel layers.

3.2.2 COMPLEMENTARY SITE INVESTIGATION FOR TEMPORARY DIAPHRAGM WALL

In order to define the elevation of the base of the temporary diaphragm wall, a specific site investigation will be performed along the diaphragm wall perimeter:

- Spacing of the boreholes: 100 m;
- Type of investigation: boreholes with continuous coring below elevation 45 and destructive drilling above this elevation;
- Minimum penetration in hard clays: 10 m;
- In four boreholes regularly spaced: penetration in hard clays 25 m;
- Minimum core diameter in the sampled length: 76 mm.

Thirty undisturbed samples will be sent to the laboratory in order to perform the following testing programme:

- 30 moisture content and dry density determinations;
- 30 Atterberg limits determinations;
- 30 unconfined compressive strength measurements;
- 15 unconsolidated undrained triaxial tests (5 series of 3 tests);
- 15 permeability measurements in the oedometer apparatus.

The works are to be performed in accordance with the specifications given in Division 02 'Geotechnical investigation'.

They are included in Bill No. 2.

3.2.3 TEMPORARY COFFERDAM DIAPHRAGM WALL

- The temporary diaphragm wall will be of the self-hardening grout type where excavation is performed under a bentonite/cement slurry which after hardening constitutes the cut off material.
- The minimum required penetration in the hard to very hard clay layer is 2 m, the elevation of the clay layer being determined in the complementary site investigation.
- The minimum width of the diaphragm wall will be 0.60 m and the tolerance on verticality 2%. The Contractor will propose procedures for measurement of verticality and width of the excavated trench.

. The required mechanical characteristics of the self-hardening grout are:

- Simple compressive strength at 28 days greater than 100 kN/m^2 and smaller than 150 kN/m^2;
- Permeability measured on samples in the laboratory less than 10^{-8} m/s. This figure corresponds to the target, but in any event permeability shall never be greater than 10^{-7} m/s.

The Contractor will propose to the Engineer a cement/bentonite mix to achieve the required mechanical characteristics.

. Two months before the works, the Contractor will submit to the Engineer:

- A detailed excavation method statement with special emphasis onto the performance of the embedment into the hard clay in terms of equipment and excavation time;
- A complete working specification including a quality control programme;
- Laboratory results documenting the selected composition of the self hardening grout and the measured mechanical characteristics: permeability, unconfined and confined compressive strength, deformation modulus;
- Programme of works;
- During the works, the Contractor will submit to the Engineer within a period of 24 hours, the daily statement giving full details of the works completed during the day and results of quality control tests performed.

3.2.4 DEWATERING

. The Contractor will propose a dewatering system to the agreement of the Engineer. He will furnish, install, maintai and operate the dewatering system until completion of the wor to be performed in the dry.

. The control of ground water will be accomplished in a manne that will preserve the strength and the characteristics of t foundation soils, will not cause instability of the excavati slopes, will result in all construction operations being performed free from standing water, will result in all foundations being sufficiently dry for proper bonding of t back fill material with the foundation and proper compaction the material placed and will not result in damage to existi structures. For the final stage of excavation, the water le will be lowered in advance of excavation.

. During excavation, the piezometric level will be such that no trafficability problems be induced for the earth moving equipment.

. Open pumping with sumps and ditches, if its results in boils, loss of fines, softening of the ground or instability of slopes, will not be permitted.

. Wells or/and wellpoints shall be installed with suitable screens and filters so that continuous pumping of fines does not occur. The discharge shall be arranged to facilitate collection of samples by the Engineer.

. Prior to beginning work, the Contractor shall submit to the Engineer for review a detailed plan of his proposed dewatering system, showing the arrangement and location of wells or/and wellpoints, methods of installation, location of headers and discharge lines, points of discharge disposal and location of piezometers.

After completion of the dewatering installation and prior to commencement of excavation, the Contractor shall submit for review a detailed plan of the dewatering system as constructed together with test data and computations demonstrating that the system is capable of achieving the specified result.

. At the final stage of excavation, the piezometric level will be maintained at least one metre below the levels shown in drawings 04 and 05 excavations for structures.

. No foundation preparation and compaction for structures, backfill or embankment will be carried out with a piezometric level less than 1 m below working level.

. In order to monitor the piezometric head in the excavation, 20 piezometers will be installed. The mean screen level will be 5 m below structure foundation level.

oOo

م/ مجدی عباس

Division 4

MATERIALS

4.1 GENERAL

The Contractor's attention is especially directed to the fact that the requirements of the Specification are general and applicable to all the Works. The various descriptions and requirements are not necessarily repeated for each separate section of the Works and they shall be held as referring to every part of the works where applicable even when the reference is not actually made.

In addition the following general requirements a) to e) shall also be held to apply to every part of the Works where applicable.

a) The whole of the materials and workmanship of the Works both temporary and permanent, shall be in accordance with the Contract as to character, type, construction, constituent substances, quality, weight, strength, shape and dimensions.

b) The Contractor shall guarantee the strength and quality of all materials and workmanship, and he shall not be relieved of his obligations with respect to the sufficiency of the materials, workmanship and works by reason of no objection having been taken thereto by the Engineer during the progress of the operations although the same may have been inspected by him.

c) The Contractor shall, when required by the Engineer, furnish all information as to quality, weight, constituent substances, dimensions, levels, strength and description of the materials and works, and give the Engineer such other particulars as may be required.

d) The Contractor shall give to the Engineer written notice of the workshops and places where work is being, or is about to be, prepared or from which materials, or manufactured articles are about to be or are supplied. He shall also give such notices and keep the Engineer advised of the times when such materials will be ready to be inspected, so that such inspection may take place without delaying the despatch of the materials to the Site. Such notices shall be given at such times as will permit of the inspection of the whole of the work at all stages of the processes of manufacture, and not only when any material is completed ready for despatch.

e) Materials which are not fully specified herein or are not covered by ASTM standards shall be submitted to the Engineer in order to determine whether all or any of the materials and supplies, etc. offered or delivered for use in the works are suitable for purpose.

4.2 CEMENT

a) Cement shall comply with the requirements of ASTM C-150

Except where otherwise specified, ASTM current type II shall be used for manufacturing the concrete of all structures.

The Contractor shall submit measures for insurance concerning the adequacy of the cement type from the chemical point of view, i.e. it should have no harmful effects on the long run on the used reinforcing steel or concrete aggregates.

b) At the Engineer's discretion the tests may be made on samples taken in the manufacturer's works prior to shipment or after arrival of the cement on site. Tests may be required for each separate consignment at the discretion of the Engineer. These tests shall include:

. Complete chemical analysis;

. The following test results:

- Soundness:

  Percent autoclave expansion (ASTM C 151);

- Time of setting:

  Vicat Method (ASTM C 191),
  Initial set, minutes, minimum time,
  Final set, hours, maximum time;

- Compressive strength:

  2 in. cubes (ASTM C 109),
  Test age - 3 days,
  Test age - 7 days,
  Test age - 28 days;

- False set:

  Paste Method (ASTM C 451);

- Fineness tests:

  Fineness tests shall be performed in accordance with ASTM C 184; the quantity retained on a 200-mesh sieve shall not exceed 18%;

- Heat of hydratation:

  It shall be performed at 7 days with a thermos calorimetre.

c) All cement shall normally be delivered to the site in sealed bags of standard weight. All necessary measures shall be taken during transport, unloading and storing to protect cement from the weather and avoid damaging the bags. The supply of cement in bulk may be allowed with the prior approval of the Engineer who will fix the conditions of transport, unloading and storing.

d) The Contractor shall provide suitable storage for cement at approved places convenient to the work, and the cement shall at all times be carefully protected against moisture and exposure to air. Cement storehouses shall be weather-tight; shall have tight floors set a proper distance above the ground; shall be large enough to maintain a sufficient supply of cement on hand to prevent delays or interruptions to the work and shall have sufficient floor space for storing each carload of cement separately and affording convenient access thereto for sampling, counting of packages and removal. Cement in packages shall not be piled to a height exceeding 2.5 metres.

e) To prevent undue aging of sacked cement after delivery, the Contractor shall use sacked cement in the chronological order in which it was delivered on the job. Each shipment of sacked cement shall be stored so that it may readily be distinguished from other shipments. All empty sacks shall be promptly disposed of by burning or means approved by the Engineer.

f) Suitable, accurate scales shall be provided by the Contractor for weighing the cement in each storehouse and elsewhere on the work, if required, and he shall also furnish all necessary test weights.

g) Bulk cement shall be stored in weather-tight bins or silos, plans of which shall be approved by the Engineer and they shall be efficiently operated and maintained by the Contractor. All such storage bins shall be constructed so that there will be no dead storage. The storage bins shall be emptied and cleaned by the Contractor when so directed by the Engineer; however, the intervals between required cleanings will normally not be more than four months. The Contractor shall not use cement directly upon its receipt, cement previously received has to be stored more than 15 days from the date of manufacture.

h) The Contractor shall employ competent storekeepers who shall have charge of the cement storehouses and keep suitable records of the delivery and use of all cement. Copies of these records shall be furnished to the Engineer at the end of each day's work, showing in such detail as he may require, the quantity of cement used during the day in each part of the work.

i) Any cement contained in bags damaged during transport or which has hardened or started to harden or become stale or been stored for more than 5 months shall in no circumstances be used in the works. Such cement shall be removed from the storage sheds and taken out of the work site or destroyed.

4.3 WATER

Water for mixing mortar, grout and concrete shall be running water from an approved source. It shall not include more than 2 parts by weight per 1000 of material in suspension and not more than 15 parts by weight per 1000 of material in solution of which not more than 0.5 part per 1000 shall be sulphates. It shall contain no organic matter either in suspension or in solution.

In all cases, the Contractor shall ascertain that the water used does not present any harmful reaction with the cement and/or aggregates used.

4.4 STEEL FOR REINFORCEMENT OF CONCRETE

Unless otherwise provided in the Contract, the steel for reinforcement shall conform with the standards as follows:

a) Plain bars shall satisfy the requirements of ASTM A 615 grade 60 (structural grade) provided that basic Bessemer process shall also be permitted;

b) Deformed bars shall satisfy the requirements of ASTM A 615 grade 60;

c) Welded steel wire fabric shall be in accordance with ASTM A 185 grade 60.

The Contractor shall furnish mill test certificates of all reinforcement furnished, which tests shall be made in accordance with the stipulations and requirements in the aforestated ASTM Standard Specifications.

4.5 AGGREGATES FOR CONCRETE

Fine and coarse aggregate for making concrete shall comply with the requirements of ASTM C 33.

a) Fine aggregate

. The fine aggregate to be used for mortar and concrete shall pass through ASTM No 4 (4.76 mm) sieve and shall be derived from natural river or pit sand except that the Engineer may permit the use of mixed sand containing crushed rock sand. Crusher dust shall not be used. Sand shall be divided into two separated size group and 2 bins shall be used for storage so that the exact proportions can be fed into the mixer as required to maintain the grading specified by the Engineer.

. The combination of the 2 sands as used in the work shall comply with ASTM C 33 for fine aggregates and the grading shall be as determined by the Contractor and approved by the Engineer within the limits given in the here above standard, with the following additional requirements:

- The sand prepared or used in the work shall be free from soluble salts. No sand shall contain more than 3% of mica and no sand shall contain more than a total of 3% of loam, silt and other impurities. The total amount of mica, loam, silt and other deleterious substances shall together not exceed 5% by weight. Tests for silt and organic impurities shall be carried out daily or as required by the Engineer. The Contractor shall provide all labour for sampling the material to be tested.

- The sand shall be stored at the Site in bins or in stock piles with concrete or timber floors and walls so as to avoid contamination or the risk of earth or clay being picked up when it is being used.

- The sand equivalent shall be not less than 75, for the mix of the two categories of sand.

- Any sand which in the opinion of the Engineer does not comply with the requirements of this specification shall be immediately removed from the Site.

b) Coarse aggregate

. Coarse aggregate for concrete shall consist of crushed or natural gravel or shingle or alternatively of broken hard close-grained stone to the approval of the Engineer. Crushed aggregate shall be of approximately cubical shape and any material which tends to break in long flakes will not be accepted. Natural gravel shall be of roughly spherical shape. The discoidal form of gravel frequently encountered in some areas will not be acceptable. All coarse aggregate shall be clean and free from dust, clay, earth and other impurities, and no weathered or decayed rock shall be used. The coarse aggregate shall be thoroughly washed as necessary and screened to the required sieve separations and all material finer than 5 mm shall be removed.

. Suitable sampling of the various sieve separations shall be carried out by the Contractor for analysis and testing and, if approved by the Engineer, all coarse aggregate used in the work shall be of a quality and a sieve separation in accordance with the accepted samples. The Engineer shall have power to reject any material supplied which does not conform to these requirements.

. Tests to check the cleanliness of the coarse aggregate shall be carried out by the Contractor under supervision of the Engineer both for organic and other impurities and the Contractor shall supply samples for carrying out all tests as specified in ASTM C 33.

. Under no circumstances shall sieve separations of more than one category be delivered to the place of gauging in the same truck or lorry.

. The coarse aggregate to be used for concrete shall consist of a number of nominal sizes. Each nominal size of coarse aggregate shall include a suitable percentage of the sieve separations applicable to its size. These sieve separations shall be as follows:

- Passing 50 mm mesh and retained on 25 mm mesh,
- Passing 25 mm mesh and retained on 15 mm mesh,
- Passing 15 mm mesh and retained on 5 mm mesh.

Thus, 50 mm nominal size coarse aggregate shall include all or some of the sieve separations between 50 mm mesh and 5 mm mesh. Similarly, 25 mm and 15 mm coarse aggregate shall include all or some of the sieve separations between the maximum specified size and 5 mm mesh.

. The Contractor may put forward alternative proposals for aggregate sizes for the Engineer's approval.

. The sieve separations shall be stored in separate bins or in separate compartments constructed on prepared surfaces of concrete or timber to the approval of the Engineer.

. Coarse aggregates shall comply with ASTM C 33. The proportions in which the sieve separations shall be determined from time to time by the Contractor under the supervision of the Engineer.

c) Variations in grading of aggregates

. The proportions of the sieve separations of the fine and coarse aggregates to be used in the concrete may be varied from time to time as required by the character of the materials used by the Contractor.

For this purpose periodic checks will be made of the grading of the combined aggregate as delivered to the mixer drums.

- No claim of any kind will be contemplated in respect of any such variations and the Contractor shall prepare his prices for concrete with the probability that such variations will be made.

- Should Site tests and experimental work show that a gap grading of the aggregates would lead to economy this may be approved by the Engineer.

d) Testing of fine and coarse aggregates

- It is the essence of this Contract that only sand and coarse aggregate, which have been tested and found to comply with the requirements of the Specification, shall be used for concrete.

- The sand shall be tested for dust, loam, silt, organic matter or other detrimental ingredients as well as for cleanliness, grading, fineness modulus and other necessary qualities, before delivery to the Batching Plant is commended, and at frequent intervals thereafter, and no sand shall be used for concrete which fails to comply with the requirements of these tests.

- The sand shall also be subject to tests for bulking as and when required and for moisture content in connection with the determination of the water-cement ratio.

- Coarse aggregate shall be tested to determine the cleanliness, hardness, grading, fineness modulus, absence of impurities and other necessary qualities before commencement of delivery to the Batching Plant, and at frequent intervals thereafter and no coarse aggregate which fails to comply with the requirements of these tests shall be used for concrete.

- Coarse aggregate shall also be subject to tests by sieve analyses before delivery to the Batching Plant is commenced, and at frequent intervals thereafter, to ensure the suitability of the grading.

- No fine or coarse aggregate will be approved for use in the works until satisfactory tests have been made on concrete test specimens.

- As and when the Engineer directs, samples shall be taken from the Batching Plant of each category of material, and of the dry mixes (with no water and no cement) for checking the grading of the aggregate.

e) Quarries

- The quarry sites chosen by the Contractor shall be approved by the Engineer before the Contractor can use them. The Contractor is nevertheless bound to give them up and open up new quarries should the materials taken from the first quarries no longer be of acceptable quality. In the event of his having to open a new quarry, the Contractor shall have no claim to payment for the exploration and development of the new quarry, nor shall he be entitled to a change in rates in the Bills of Quantities.

- Within one month of the Contractor's request for permission to use a particular quarry the Engineer will give or refuse his assent to such use.

- The Engineer shall not approve of any quarry site submitted by the Contractor (and in any case shall not apply the period of one month mentioned above) unless the Contractor has first of all carried out boreholes and trenches in sufficient quantity and to an adequate depth and over the whole surface of such quarries and shall have carried out crushing tests, so that the Engineer can have to hand all the information he requires for enabling him to appraise properly the quality and quantity of the materials proposed.

f) Inspection details and frequency of testing

- Fine aggregate

  - Grading

    Once during each 2 days when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination for the fine aggregate type for each fine aggregate, if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor under supervision of the Engineer.

  - Fineness modulus control chart

    Results for fineness modulus shall be grouped in sets of three consecutive tests and the average and range of each group plotted on a control chart. The upper and lower control limits for average shall be drawn 0.06 units above and below the target fineness modulus, and the upper control limit for range shall be 0.19.

- Sand equivalent

  Once 3 tests during each day when the concrete plant is operating there shall be one sand equivalent test for the fine aggregate type for each categorie of fine aggregate.

- Moisture content

  There shall be, when, in the opinion of the Engineer the electric moisture meter is not operating satisfactorily, at least two pairs of tests for moisture content during each day period of mixing plant operation. The two test in each pair shall be spaced one hour apart and the times for the pairs shall be selected randomly within the day period. An additional test shall be made whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, at least two direct measurements of moisture content shall be made per week the calibration of the meter.

. Coarse aggregate

- Grading

  Once during each week in which concrete plant is operating, there shall be a sieve analysis for each size of coarse aggregate. Samples shall be taken from the batch plant bins. Each test record shall show the results of the current test as well as the average results of the five most recent tests including the current test. When tests at other locations are necessary for control, these shall also be recorded. For these tests the Contractor may adopt limits for control coarser than the specification limits of allow for degradation during handling.

- Moisture content

  A test for moisture content of each size of coarse aggregate shall be made at least once a day.

  When two consecutive readings for smallest size coarse aggregate differ by more than 1.0%, frequency of testing shall be increased to that specified for fine aggregate in 1) third paragraph.

- Particle shape

When, in the opinion of the Engineer, a problem exists in connection with aggregate particle shape, tests shall be made. In this case testing frequency shall be not less than one per day.

- Material finer than No. 200 sieve

When in the opinion of the Engineer, a problem exists in connection with the cleanliness of aggregate, tests shall be made in accordance with ASTM-C-117. Testing frequency shall be not less than one per day.

g) Action required

. Fine aggregate

- Grading

When the amount retained on any sieve is outside the specification limits, the fine aggregate shall be resampled and retested. If there is another failure on the same sieve, the fact shall immediately be reported to the Engineer. All such tests shall be included in the control charts. Whenever a point, either for average or range, is beyond one of the control limits the frequency of testing shall be doubled. If two consecutive points are beyond the control limits, the process shall be considered out of control. The Engineer shall be notified, and immediate steps shall be taken to rectify the situation. After two consecutive points have fallen within the control limits, testing at the normal frequency may be resumed.

- Moisture content

Whenever the moisture content of the fine aggregate changes by 0.5% or more, the scale settings for the fine aggregate batcher and water batcher shall be adjusted directly or by means of a moisture compensation device. If, at any time, the requirements for moisture variation are not met, the Engineer shall be notified and immediate steps shall be taken to reduce the variation.

- Sand equivalent

Whenever the sand equivalent result is less than 70, the sand shall be resampled and retested. If there is another failure the fact shall immediately be reported to the Engineer and immediate steps shall be taken to correct the grading.

. Coarse aggregate

- Grading

When the amount passing any sieve is outside the specification limits, the ccarse aggregate shall be resampled and retested. If the second sample fails on the same sieve, that fact shall be reported to the Engineer. When two consecutive tests where large samples are used are outside of specification limits, that fact shall be reported to the Engineer and immediate steps shall be taken to correct the grading.

- Moisture

Whenever the moisture content of the smallest size of coarse aggregate changes by I.5% or more, the scale settings for the aggregate batcher and water batcher shall be adjusted directly or by means of a moisture compensation device. If, at any time, the requirements for moisture variation are not met, the Engineers shall be notified and immediate steps shall be taken to reduce the variation.

- Particle shape

When testing for particle shape is required, two consecutive failures in the same sieve size shall be immediately reported to the Engineer, who shall provide instructions as to the necessity for corrective action.

- Material finer than No. 200 sieve

When testing for material finer than No. 200 sieve is required by the Engineers and the test results show deviation from specified value. The Engineer shall be notified and steps, such as washing or other corrective action, shall be initiated immediately.

h) Reports

All results of tests conducted at the project site shall be reported daily and shall be delivered in a bound form to the Engineer representative within three days after the end of each weekly reporting period. Each weekly report shall include the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold and hot weather conditions, reports of pertinent temperatures shall be made daily. These requirements do no relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Engineer has the right to examine all Contractor quality control records.

4.6 EXPANSION JOINT FILLER

Filler for expansion joints in concrete shall consist of a compressible, resilient, non-extruding, durable material. It shall be rot-proof and fully waterproofed. It shall conform to the ASTM Designation: D 1751.

4.7 CONCRETE JOINT SEALING COMPOUND

Concrete joint sealer shall comply with ASTM D 1850.

The joint sealer shall be composed of a mixture of materials that will form a resilient and adhesive compound capable of effectively sealing joints in concrete against the infiltration of moisture and foreign material throughout repeated cycles of expansion and contraction with temperature changes, and that will not flow from the joint. The sealing compound should be suitable for completely filling the joints without inclusion of large air pockets or discontinuities.

Back up material shall be used to control sealant depth and to isolate sealant from uncompatible materials such as bitumen.

Back up material shall be a closed cell foam rod having a diameter 25 to 40% larger than nominal joint with.

The Contractor shall submit Manufacturer's literature and samples at the latest 2 months before intended utilisation date.

4.8 BUILDING PAPER

Building paper shall be tough and durable and suitably waterproofed with bitumen. It shall be of approved manufacture and quality.

4.9 BRICKS

Bricks shall be hard, machine made, of good shape, sound, kiln burnt and even in size and shall be obtained from an approved source. They shall be of the best quality manufactured in Egypt and suitable for load bearing walls and shall be approved by the Engineer.

4.10 STONE FOR RIP RAP AND ROCKFILL FOR RIVER CLOSURE

Only stone which has been approved by the Engineer shall be used in rip-rap or rockfill for river closure. It shall satisfy the following conditions:

- Have adequate hardness to be loose dumped and manipulated by mechanical means without breaking up;
- Be homogeneous and not spoil in air and water;
- Minimum specific gravity of 2.4 t/m^3;
- Minimum unconfined compressive strength: 250 kg/cm^2;
- Weight loss less than 10% after five cycles of submersion-drying in a sodium-sulphate solution (ASTM C 88);
- Weight loss less than 45% after five hundred revolutions in a Los Angeles apparatus (ASTM C 535);
- Stones showing veins liable to become a breaking-point shall be first partitioned; the specified weight shall be the weight of each element after partition;
- Largest dimension of the stone not more than three time the smallest one.

4.11 TIMBER

All timber used in the works shall be sound, free from sapwood, shakes, large and loose knots, waney edges or other defects, cut from mature trees and well seasoned; it shall be sawn all round die-square and be of the kind and scantling most suitable for the purpose for which it is required.

Timbers used for kerbs, fenders and walling shall be of greenhart specie with the following properties:

Specific gravity at 18% moisture content — 1,060 kg/cm^3

Ultimate stresses parallel to grain:

Compression	700 kg/cm^2
Shear	90 kg/cm^2

Modulus of elasticity — 180,000 kg/cm^2

Greenhart specie shall be creosoted to a retention of 180 kg/m^3.

4.12 STRUCTURAL STEEL

4.12.1 STEEL PIPES FOR DOLPHINS AND MOORING POSTS

Steel will conform to API 5 LX Grade X 52, yield strength 360 MPa (52 ksi). Due to the carbon equivalent of this steel low hydrogen welding process is to be used.

4.12.2 OTHER STRUCTURAL STEEL

Other structural steel plates and shape will conform to ASTM A 36.

Steel pipes to support gaugway will conform to ASTM A 135 Grade B.

Bolts, ragbolts, nuts and washers shall conform to ASTM A 325 Grade A.

Steel pipes, pipe sleeves and similar uses shall conform to the requirement of ASTM A 120.

4.13 WATERSTOPS

Rubber waterstops shall be 35 cm wide of the dumb bell type with hollow centered bulb. The rubber shall have a minimum tensile strength of 20 MPa at 25°C and a minimum elongation of 500 % of break. Hardness shall be between 60 to 65 IRHO at 25°C.

4.14 REINFORCED NEOPRENE BEARINGS

Bearings shall be made of neoprene bearing pads reinforced with standard steel plates. Three months after the issuance of the order to proceed with the works the Contractor shall submit for the approval of the Engineer, specifications, notices and references of the suppliers.

The bearings shall comply with ASSHTO M 251.

4.15 BENTONITE

Detailed specification for bentonite is given in Division 9.

4.16 CLAY

Specification for clay is given in Division 9.

4.17 PLASTIC CONCRETE

Specification for plastic concrete is given in Division 9.

oOo

Division 5

EXCAVATIONS AND EARTHWORKS

5.1 GENERAL

5.1.1 All excavation and earthwork required to be performed under the Contract and for all related purposes, and as may be required by the Engineer, shall be performed and executed in accordance with the stipulations and requirements stated herein. The stipulations and requirements herein set forth shall apply except when such stipulations and requirements are specifically modified in writing by the Engineer for any particular item of work.

5.1.2 OVERHAUL

Generally all earth moving shall be carried out inside the site reserve limit defined on the drawings. If, nevertheless, at the request of Engineer either excavation materials are hauled outside the site reserve limit, or backfill and embankment materials other than those derived from the pit run gravel are hauled from outside to inside the site reserve limit, these transportations shall be classed and paid as overhaul. For the materials derived from the pit run gravel of the gravel plain and for transitions, rip-rap and rockfill, the cost of transportation from outside the site reserve limit will be included in the unit rate and there will be no payment of overhaul.

5.2 EXCAVATIONS

5.2.1 CLEARANCE OF SITE

a) All areas within the site reserve which require clearing, as determined by the Engineer, shall be cleared of all trees, brush, rubbish and other objectionable matter and such materials shall be removed from the site of the work or otherwise disposed of as approved by the Engineer. In general, only such trees that would interfere with the construction required under the Specifications shall be removed and trees along the site reserve shall be left in place to the greatest extent practicable, as determined by the Engineer.

All trees cleared from the site shall be placed and/or piled at locations designated by the Engineer along the site reserve and shall remain the property of the Employer. Fences, walls, buildings, ruins and other structures which interfere with the works shall also be cleaned from the site of the works and shall be suitably disposed of as directed by the Engineer. The Contractor will be required to keep clearing operations well in advance of other construction operations.

b) Any damage to the works and public or private property caused by the Contractor's operations in clearing shall be repaired or replaced at the expense of the Contractor.

5.2.2 STRIPPING

The ground surface under the area concerned by excavations, embankments channel, roads, etc. shall be stripped as required to remove all stumps, roots, vegetable matter, top soil and other objectionable material, as determined by the Engineer. The material removed shall be disposed of in spoil banks designated by the Engineer. Stripping of the ground surface under spoil banks and disposal areas will not be required. Stripping under temporary stock piles is required.

Top soil removed from the work-site shall in no circumstances be used for embankments. The stripping depth is as shown on the Drawings or as directed by the Engineer and generally 20 cm for compacted embankments.

5.2.3 EXCAVATION

5.2.3.1 General

a) Except as otherwise provided in the Contract, no classification will be made for payment purposes of any material excavated as to its class, nature, origin or condition.

b) Except as otherwise stated in the contract, no distinction will be made between excavations performed in the dry and excavations performed under water. But for payment purposes, a distinction is made between excavations inside the cofferdam and excavations outside the cofferdam. The cofferdam is defined by its axis as shown in drawing NE-06.

c) All excavation shall be made in accordance with the provisions of this section and to the lines and grades shown on the Drawings or established by the Engineer.

d) The cost of any extra excavation and compacted backfill in respect of working space for placing shuttering or otherwise shall be born by the Contractor.

e) During progress of the work, it may be found necessary or desirable by the Engineer to vary the slopes or the dimensions of the excavations from those shown on the Drawings or specified herein. The Contractor shall perform the work and make the required excavations to the revised and changed slopes and dimensions in accordanc with these Specifications.

f) Where excavations are not to be covered by structures or other required construction they shall be made to the full dimensions required and shall be finished to the prescribed lines and grades. All necessary precautions shall be taken to preserve the material below and beyond the lines of all excavation in the soundest possible condition. Any and all excavation made for the convenience of the Contractor for any purpose or reason, except as otherwise provided herein, shall be refilled and possibly compacted, where required to complete the work, by the Contractor.

g) Programme and method

The Contractor shall submit to the Engineer for his approval drawings of excavations showing the limits of excavation, the accesses, the sequence of work, the location of permanent fill, temporary stockpiles and spoil areas.

The Contractor shall co-ordinate his excavations and fill requirements so that suitable excavated materials shall be selected during the excavation operations and shall be placed in permanent locations or temporary stockpiles to minimise leads and lifts.

h) The temporary retaining structures shown on the excavation drawings NE-04 and NE-05 will be proposed by the Contractor. They will not be paid under a special item. Their cost will be spread over the excavation for structure item.

5.2.3.2 Excavated material

a) Excavated materials containing stumps, roots, vegetable matters and other objectionable materials shall be placed in designated spoil banks.

b) It is anticipated that the major part of the material from the required excavations inside the cofferdam will be poorly graded medium to coarse sands with little fine content (generally less than 12%) plotting SP or SP/SM in USCS soil classification.

Locally and more especially in the lock area, more silty fine sands plotting SM in USCS soil classification may be encountered.

c) Findings similar to b) apply also for excavations outside the cofferdam in the Nile main bed.

d) It is anticipated that a large part of the materials from required excavations will be suitable for use as embankment material. Where practicable, all suitable materials shall be placed in the designated final locations direct from the excavation, except either backfill materials or materials with too high moisture content.

Excavated material which cannot be reused directly will be sent to temporary stock pile or to spoil bank. The temporary stock pile can be used as borrow area for embankment materials and, if necessary, closure dam materials deposited under water provided material specifications are met.

e) The Contractor will submit to the Engineer a detailed excavation/embankment construction programme.

5.2.3.3 Use of dredging for excavations

a) Dredging can be used to start excavations in the temporary cofferdam and to perform common excavation outside the cofferdam. During the dredging operations, the Contractor will leave a free navigation channel as required in Division 1. The same requirements apply for any dredging performed anywhere on the site.

b) If the dredged materials cannot be reused directly, they will be deposited in temporary stock piles or in the spoil bank area depending on material type and programme of embankment construction.

c) f a large volume of very silty or clayey sands (more than 15% in weight passing n° 200 ASTM) is identified in the areas to be dredged, this material will be sent in the spoil bank area.

d) Sands with less than 12% fines in situ (see § 5.3.5.2) can be hydraulically deposited in the closure dam. The dispositions required in § 5.3.2.2 for hydraulic filling are to be followed.

5.2.3.4 Permissible tolerances for excavations

Except where otherwise specified or shown in the Drawings, tolerance shall be as follows:

- Vertical tolerance applies to bottom, berms and foundation;
- Width tolerances are measured horizontally at any level on the slopes and sides and refers to the distance from the relevant centre line.

Tolerances for the various excavations will be as follows:

- Excavation for structures
  - vertical: + 0 / - 0.25 m
  - width: + 0.25 m / - 0
- Excavation for channels including drains: + 0 / - 0.25 m in all directions

In any case, the payment shall be made only as per lines and grades shown on the drawings without considering these tolerances.

5.2.3.5 Slide materials

Materials which will not stand on the slopes shown on the Drawings or established by the Engineer and materials which are a part of slides extending beyond the established lines of excavation but which move into excavated areas, shall be removed by the Contractor in an approval manner, and the slopes shall be refinished to lines and grades established by the Engineer. The Contractor may be required to excavate potential slide areas beyond the limits of the originally stated excavation where, in the judgment of the Engineer, such excavation is necessary to prevent damage to the works.

This material shall be measured as common or structure excavation as the case may be and as directed by the Engineer.

5.2.4 PREPARATION OF STRUCTURE FOUNDATION

5.2.4.1 General

a) The bottom and side slopes of the excavations upon or against which structures or other required construction are to be placed shall be finished accurately to the required grade and dimensions as shown on Tender drawing n° NE-04 and 05.

b) If, at any point in the excavation, material is excavated beyond the established lines and grades, the over-excavation shall be filled with concrete or selected materials, as ordered by the Engineer, at the expense of the Contractor. Whenever the natural foundation material is disturbed or loosened because of the Contractor's excavation operations, it shall be consolidated by tamping or rolling or, if required by the Engineer, it shall be removed and replaced with concrete or selected material as stated above at the expense of the Contractor.

c) Inside the cofferdam and during the final stage of excavations and preparation for structure foundation, the water table will be maintained 1.5 m below final excavation level.

d) The bottom of large excavations for structures will be compacted with a smooth drum vibrating roller type 1 (see Section 5.3.6.2). Eight passes are to be performed. A lighter roller (type 2) will be used for smaller excavations when access and operation of heavy roller is not possible. Moistening of the soils will be performed before compaction.

5.2.4.2 Material unsuitable for foundations

a) If, at any point in any structure excavation, material unsuitable for foundations is encountered, as determined by the Engineer, the Engineer will order, in writing, removal of all such materials and refilling with selected materials thoroughly compacted. The backfill material will be sand or sand and gravel mixture as defined in 5.3.5. The acceptance criteria for compaction will be the most stringent of the following requirement:

- Dry density at least equal to 97% of modified Proctor maximum density (ASTM DI 557);
- Relative density at least equal to 75%.

b) Under the main concrete structures, foundation material will be considered as unsuitable for foundations and replaced by compacted backfill when the material is a fine cohesive soil (SC - CL - CH in USCS soil classification) with an undrained shear strength Cu less than 120 kN/m². Quick determination of the undrained shear strength will be performed with a field inspection vane.

c) The trenches for pipes will be over excavated and backfilled prior to the placing of pipes when the encountered soil is a soft clay.

5.3 BACKFILL AND EMBANKMENTS

5.3.1 TERMINOLOGY

All fill or refill about structures that is within the slopes and limits of the established pay lines for excavation for the structures and below the natural ground level shall be named and placed as backfill or compacted backfill.

All fill or refill about structures that is above the natural ground level shall be named and placed as embankment or compacted embankment except as otherwise specifically shown on the drawings or provided in the Contract.

5.3.2 GENERAL

5.3.2.1 Works performed in the dry

a) The Contractor shall construct all embankments required under the Specifications to the lines and grades shown on the drawings or established by the Engineer including, but not limited to, embankments which form the river banks and roads, spoil banks for disposal of excess material and all other embankments shown on the drawings or directed by the Engineer.

b) Embankments, including spoil banks, shall be built in approximately horizontal layers carried across the entire width of the embankment to the required slopes. Embankments shall not be widened with loose material dumped from the top. Embankments may be built by mechanical excavating and hauling equipment, or by excavating machinery depositing the materials directly from the excavation. Embankments built by mechanical excavating and hauling equipment shall be kept as close to level as practicable and the travel of equipment over the embankments during construction shall be routed so as to distribute the compacting effect of the equipment to the best practicable advantage.

c) Wet material, unless otherwise determined by the Engineer to be unsuitable, will be required to be utilised in embankments and an excess moisture content shall not be cause for rejection. The Contractor shall plan his embankment placing operations to include adequate delays, stockpiling and placing later, mixing with dry material, or other procedure or combination of procedures as may be required to permit the material to be placed in the specified embankments at a proper moisture content.

d) All spoil banks and waste areas shall be levelled, by layer not more than 1.00 m thick, and sloped to drain, and trimmed to reasonably regular lines as shown on the drawings or as directed by the Engineer. The final elevation of the spoil bank will be el 79.

5.3.2.2 Embankment construction under water and hydraulic filling

a) During the hydraulic filling operation for the central part of the closure dam, there will be no interruptions or obstruction to the navigation which will transit through the lock.

b) Material specification for hydraulic filling of the closure dam is given in Section 5.3.5.2 a).

c) In any underwater embankment construction, it will be attempted to limit segregation.

d) The hydraulic filling operation for the closure dam is to be performed in such a way that the small proportion of fines present in the material does not collect into mud pockets or mud layer.

e) For the closure dam, inspection by divers will be performed during construction to check that there is neither mud pocket nor thin mud layer at the surface of the fill. Controls will be especially reinforced after construction interruptions before resuming the hydraulic filling operations. If such pocket or layer is found, it will be excavated or washed away.

f) In addition to the controls of the borrow material, grading analyses of fill after hydraulic deposition are to be performed in the closure dam. Frequency of tests: one every 2 500 m^3.

g) For temporary stock piles constituted by hydraulic filling, the hydraulic fill is to be placed in such a way that the fines are not allowed to collect into mud pockets in the reclamation area. More especially, the formation of ponds in the reclamation area will be avoided.

The layout of containment bunds, overflow weirs, discharge pipes and drainage channels will be adapted to achieve the above mentioned objective.

Grading analysis (one per 2500 m^3 of fill) will be performed in locations considered as potential borrow area.

h) In the spoil bank area the dispositions required in g) to avoid mud pockets will be followed.

5.3.3 PREPARATION OF GROUND SURFACE UNDER COMPACTED EMBANKMENTS

This section is valid for embankments constructed in the dry.

After the required stripping has been completed, the ground surface under all embankments and load base layers shall be scarified and/or ploughed thoroughly to a depth of not less than 20 cm, shall be moistened if required, and compacted with the same specification as the supported embankment or road base layer.

5.3.4 PERMISSIBLE TOLERANCES

All embankments shall be trimmed so that their final level after settlement does not exceed that specified by more than 0.20 m and so that their inner and outer slopes are not steeper than those specified. The top width, the berm width and the top level of embankments in which the bank top level is shown as being above natural ground level shall not be less than shown on the drawings.

5.3.5 BACKFILL AND EMBA' 'ENT MATERIALS

5.3.5.1 General

Backfill and embankment materials can be divided in:

a) Sandy material coming directly from the excavations or from temporary stock piles constituted with excavated material;

b) Sand and gravels obtained from the pit run gravels from river plain. These pit run gravels will be used, with some processing if needed to fulfil specifications, for:

- transition layer,
- filling of concrete caissons unless otherwise directed by Engineer,
- embankment materials for upstream and downstream lock groynes,
- road base,
- backfill material for stone column (see Section 11) if stone columns are required by the Engineer.

Unless otherwise directed by the Engineer, the use of pit run gravel will be limited to the above mentioned uses.

The gravel plain being a stratified deposit, the excavation will be performed on a vertical face in order to obtain a satisfactory mixing of the different sublayers in case of use of the pit run gravel without processing.

5.3.5.2 Sandy materials from excavation or temporary stock pile

Their grading will satisfy the following requirements:

a) For the hydraulically deposited sands of the closure dam or any other hydraulically deposited sand, the percentage in weight passing ASTM sieve n° 200 measured at the excavation or borrow area location will be less than 12%. The same requirement will apply to sands used as backfill material for vibroflotation or sand columns. This requirement will also be followed in case of backfilling of caissons with sands.

b) For backfill and embankment materials placed in the dry, sands with up to 35% in weight passing the ASTM sie e n° 200 will be accepted. The use of other materials will be subjected to the agreement of the Engineer.

5.3.5.3 Material derived from pit run gravel

a) Embankment materials for upstream and downstream lock groynes

The material will fulfil the following grading requirement:

ASTM sieve Square opening (mm)	6 in (152)	3 in (76)	3/4 in (19)	n° 4 (4.75)	n° 30 (0.600)	n° 200 (0.074)
Percentage passing in weight	100	80-100	40-70	15-40	0-10	Less than 5%

b) Material for caissons filling

Unless otherwise directed by the Engineer, the specification of 5.3.5.3 a) will be satisfied.

c) Transition layer

See Section 5.4.3.

d) Road base

See section 5.9.

5.3.6 COMPACTION

This section is devoted to embankment and backfill compaction performed in the dry.

5.3.6.1 General

a) Embankments and backfill designated on the drawings or by the Engineer as compacted shall be compacted to the lines, grades and slopes shown on the drawings or established by the Engineer.

) Prior to and during placement operations, the material shall have a moisture content in a range allowing the compaction criteria of § 5.3.6.3 to be achieved. The moisture content shall be uniform throughout each layer. Insofar as practicable, as determined by the Engineer, the material shall be brought to the proper moisture content at the site of excavation. If the moisture content is less than optimum for compaction, the compaction operations shall not proceed, except with the specific approval of the Engineer, and the moisture shall be supplemented by sprinkling and reworking the material at the site of compaction. If the moisture content is greater than optimum for compaction, the compaction operations shall be delayed until such time as the material has dried to the optimum moisture content or the material shall be dried by reworking, mixing with dry materials, or other approved means.

c) The placing operations will be such that the backfill or embankment material be homogeneous without segregation. The material will be deposited in horizontal layers.

d) For those portions of embankments or backfill adjacent to structures, including concrete or other pipes, where compacted embankment or backfill is required and it is not possible to obtain adequate compaction with rolling equipment, the embankment or backfill shall be compacted with mechanical tampers or vibrating plates of adequate weight and design so as to obtain the same degree of compaction as the adjacent compacted embankment or backfill.

The thickness of the layer will be adapted in order to fulfil the compaction requirement. Particular care shall be taken to ensure adequate bonding of material with the adjacent compacted embankments. The Contractor shall be responsible for any damage to structures caused by his operations in placing or compacting embankment or backfill material adjoining structures and any damage to structures shall be repaired at the expense of the Contractor.

e) In placing and compacting backfill or embankment material adjoining concrete or other pipes, sufficient material shall be carefully placed on both sides of the pipe and tamped about the pipe as it is laid to hold the pipe firmly to established line and grade. The material shall then be placed and compacted in layers as herein specified equally on both sides of the pipe to prevent displacement of the pipe during the placing and compacting of the adjoining material.

f) Trial embankments

Trial embankments will be constructed before beginning the works in order to determine the thickness of the lift and the number of passes of compaction equipment necessary to achieve the dry densities required in the specification.

5.3.6.2 Compaction equipment

For compaction of backfill and embankment materials specified in § 5.3.5, the Contractor will provide in sufficient number the following equipment:

. Smooth drum vibrating rollers

Roller type n°	1	2	3
Minimum static weight or vibrating drum (t)	10	5	0.7
Drum maximum width (m)	2.20	2.00	1.00
Minimum static weight per unit length of vibrating drum (kg/cm)	45	25	7
Centrifuge force (t)	20	12	3
Vibrating frequency	1400/1800 rpm	1400/1800 rpm	3300 rpm

. Vibrating plates and hand operated compaction equipment

This equipment will be used for compaction of backfill in the vicinity of structures where heavy mechanical equipment cannot be operated.

5.3.6.3 Compaction criteria

a) For soils with little fine content, the criteria will be given in terms of relative density

$$DR\ \% = \frac{e_{max} - e}{e_{max} - e_{min}} \times 100$$

or

$$DR\ \% = \frac{\gamma^{d}_{max}}{\gamma^{d}} \cdot \frac{\gamma^{d} - \gamma^{d}_{min}}{\gamma^{d}_{max} - \gamma^{d}_{min}} \times 100$$

with:

e_{min}	Void ratio in densest condition
e_{max}	Void ratio in loosest condition
e	In place void ratio
$\gamma_{d_{max}}$	Dry unit weight of soil in densest condition
$\gamma_{d_{min}}$	Dry unit weight of soil in loosest condition
γ_d	In place dry unit weight

Densest and loosest conditions will be determined in accordance with ASTM D 2049.

b) For soils with a large fine content, the criteria will be a given percentage of the maximum dry density determined with ASTM D 1557.

c) As backfill and embankment materials can be variable, two criteria will be given. For materials borderline between little and large fine content, the acceptance criteria will be the most stringent of the two.

		Most stringent of the two criteria	
		% OPM	DR %
Sandy backfill and embankment material from excavation or stock pile	Closure dam sands above el 75	≥ 97	≥ 75
	Backfill material under structure to replace unsuitable soils	≥ 97	≥ 75
	Other backfill and embankments	≥ 95	≥ 70
Sand and gravels derived from pit run gravels	Embankment materials for upstream and downstream lock groyne	≥ 97	≥ 75
	Caisson filling	Simple gravity filling	

d) The thickness of the layers and the placement moisture conte will be such that the required above density be obtained in the whole compacted layer with the vibrating rollers specified in § 5.3.6.2.

e) The compaction in the central part of the closure dam sands between Nile river bed and El 75 is covered in Section 11: Soil treatment.

5.3.6.4 Controls

a) Compaction shall be tested by the Contractor under supervision of the Engineer as the work proceeds and after completion of the embankments. The frequency of testing shall be of one test for each 2,500 m^3 of material in place.

c) Should the tests give a result lower than the specified standards, compaction shall be re-done at the Contractor's expense until the minimum specified figures are obtained. If the minimum figures cannot be obtained, the Contractor shall at his own expense demolish the defective section, remove the fill which is not approved and replace it by suitable fill.

5.4 FILTERS AND TRANSITION

5.4.1 FINE TRANSITION LAYER T1 (filter)

Sand for the fine transition layer T1 will be in accordance with the fine aggregate grading specified in ASTM C33 with less than 5% particles in weight finer than ASTM sieve n° 200.

5.4.2 COARSE TRANSITION LAYER T2

The transition layer will fulfil the following grading requirement:

ASTM sieve square opening (mm)	2 in (50)	1 1/2 in (37.5)	3/4 in (19)	N° 4 (4.75)	N° 8 (2.36)	N° 200 (0.074)
Percentage passing in weight	100	90-100	65-85	15-30	0-10	Less than 3%

5.4.3 COARSE TRANSITION LAYER T3

The pit run gravel from river plain will be used to obtain this transition layer. Processing will be performed if necessary to fulfil the following grading requirement:

ASTM sieve square opening (mm)	6 in (152)	3 in (76)	3/4 in (19)	N° 4 (4.75)	N° 30 (0.600)	N° 200 (0.074)
Percentage passing in weight	100	80-100	40-70	15-40	0-10	Less than 5%

These gradir; requirements are identical to that asked for the embankment materials for lock groynes.

The excavation process in the gravel plain will be such that mixing of the horizontal sub-layer of the natural deposit will be performed.

The unloading of the material on the final location will be performed in order to avoid segregation.

5.4.4 TOLERANCES

The vertical tolerances permitted after adjusting grades and level will be:

Slope and channel protections ———— - 0; + 10 cm
Below concrete structures ———— - 5; + 0 cm

5.4.5 COMPACTION

When located under concrete structures or concrete slabs filter and transition material T1, T2, T3 are to be compacted at 75% relative density. Grading requirements in that case must remain fulfilled after compaction.

5.4.6 CONTROL

One grading analysis per each 1,000 m^3 placed of the three type of filter and transition is to be performed.

5.5 RIP-RAP

The rip-rap does not need to be compacted but will be placed in such a manner that the largest rock fragments are uniformly distributed in the rip-rap layer.

The gradations of the rip-raps will fulfil the following criteria:

	Rip-rap type		
	A	B	C
Minimum size (mm)	200	100	30
Maximum size (mm)	700	200	70
50% in weight bigger than (mm)	500	150	50

5.6 ROCKFILL FOR RIVER CLOSURE

The gradation of the rockfill for river closure will be that of rip-rap B:

- Minimum size: 100 mm,
- Maximum size: 200 mm,
- 50% in weight bigger than 150 mm.

5.7 UPSTREAM AND DOWNSTREAM LOCK GROYNES

The upstream and downstream lock groynes are to be constructed to the dimensions shown on tender drawings No. NE-12 and NE-13. Material will be the sand and gravel derived from pit run gravel as specified in § 5.3.5.3. Compaction will be that required in § 5.3.6.3.

The requirement concerning compaction applies also for the part of the groynes which could be constructed under water. Vibrocompaction or any suitable soil treatment will be performed to achieve the required relative density in the section built under water.

5.8 CLOSURE DAM

5.8.1 The closure dam is to be constructed to the dimensions shown in drawing No. NE-29. In principle, the construction steps will be as follows:

- Installation of an unwoven fabric filter on the Nile river bed;
- Hydraulic deposition of a coarse transition layer T 2;
- Immediate protection of the T 2 layer with a layer of rockfill for river closure (material specification 5.6);

These 3 operations will be preferably performed during cofferdam construction. Then after construction in the dry of the structures, construction steps will be:

- River closure operation with dumped rockfill (material specification 5.6);
- Installation of transition layer on upstream face of dumped rockfill. Installation of unwoven fabric filter;
- Dumping of upstream toe abutment;
- Hydraulic sand filling of dam between Nile river bed and El 75. The material will satisfy grading requirements given in § 5.3.5.2. It will come directly from excavations or from temporary stock piles;
- Construction and compaction of embankment in the dry at El +77;
- Vibroflotation of the central part of the closure dam. Penetration in Nile river bed: 6 m;
- Construction and compaction of embankment at El +81;
- Construction of plastic concrete diaphragm wall;
- Complete construction of embankment;
- Slope protections;
- Roadway construction.

Alternatives can be proposed by the Contractor, especially on the phasing between soil treatment and earthworks.

5.8.2 For the hydraulic sand filling, dispositions of § 5.3.2.2 are to be followed.

5.9 ROADWAYS, SERVICE ROADS, TRACK AND ACCESS TRACKS

5.9.1 ROADWAYS

On the closure dam and in other locations as shown on the drawings or where ordered by the Engineer, roadway shall be built according to the following specifications:

a) Unwoven fabric on foundation.

b) A 50 cm base layer of sandy gravel material compacted at not less than 95% of modified Proctor Optimum Density (ASTM D 1557).

The material will be derived from pit run gravel from the river plain. It will conform to the following limits of gradation.

Sieve size	Per cent passing
50 mm	100
25 mm	75 - 100
5 mm	25 - 50
0.4 mm	10 - 30
80 µ	Less than 50% of the passing 0.4 mm

The sand equivalent (ASTM D 2419) shall be between 50 and 70.

c) A cutback (liquid asphalt of medium curing MC 70) shall be sprayed over the base at a rate of 0.7 to 1 kg per square metre.

d) A 5 cm wearing course shall be made of a ready mix asphalt-concrete spread with a greader and then compacted; the wearing course shall have the following characteristics;

. The aggregate shall be of crushed gravel conforming with the following gradation:

Sieve size	Per cent passing
25 mm	100
20 mm	85 - 100
5 mm	45 - 65
2.5 mm	30 - 50
315 µ	12 - 23
80 µ	4 - 8

The portion of the total aggregate passing the 400 μ sieve shall have a plasticity index of not more than 6; weight loss shall be less than 50 per cent after five hundred revolutions in a Los Angeles apparatus;

- Content of asphalt penetration grade 60/70 (ASTM D 946) shall be between 4 and 6 per cent;
- Marshall stability (ASTM D 1559) shall not be less than 3250 newtons and the flow value less than 16 hundredths of an inch (4 mm).
- Degree of compaction not less than 97 per cent of the standard specimen specific gravity (ASTM D 1074).

The work includes: execution of subbase, base, wearing course, surfacing and finishing of the road.

5.9.2 SERVICE ROADS

The layout of Service Roads shall be as shown in the drawings or as directed by the Engineer. The width of the Service Roads shall be 6 m plus a 1 m berm on each side. Unless otherwise ordered the height of the fills after settlement due to lorry-traffic shall never be less than thirty centimetres over the natural ground level or over the general foundation level. The fills shall be covered with a sandy-gravel layer thirty centimetres thick.

For the grading and compaction, the sandy gravel layer will conform to the same specification as the base layer for roadways (see § 5.9.1 b).

The surface shall be harrowed to a depth of 3 cm and it shall be sprayed with crude oil or if ordered by the Engineer by special product so as to saturate the surface.

The spraying shall be renewed twice at least at fortnightly intervals.

5.9.3 Not used.

5.9.4 ACCESS TRACKS

To facilitate access for setting out and construction of the Works, the Contractor shall form continuous access tracks, including all necessary temporary diversions and bridge works to and along the length of the Works on alignments agreed with the Engineer. These tracks shall be completed well in advance to setting out and construction of the Works in the relevant section of the Works. The tracks shall be of a size and condition to permit easy passage of light motor transport and wherever necessary to permit easy passage of the Contractor's and Subcontractors' lorries. Tracks shall be maintained in this condition until such time as the Engineer deems them to be superfluous.

5.9.5 ROAD SIGNS

Road Signs in conformity with the Egyptian Roads and Bridges Regulations shall be placed by the Contractor in a suitable way along the roads, tracks, near the bridges, water channels and pipe crossings and any other point wherever found suitable by the Engineer and before opening of these ways to the traffic. The cost of the road signs shall be deemed to be included in rates given in the Bill of Quantities and no separate payment will be made to the Contractor in this respect.

5.9.6 ROAD DITCHES

Road ditches shall be excavated along the Service Roads, Roadways and tracks for drainage as shown on the drawing or directed by the Engineer. Their cross section shall be at least 0.30 m^2 and their depth never less than 0.50 m. Their bed shall have a continuous longitudinal slope to convey water to a lower section of the ground.

Where necessary, the crossing of the road platform by drainage pipe culverts shall be provided.

5.9.7 THIRD PARTY TRAFFIC

The Service Roads, tracks, and roadways (hereafter referred to as the roads) ay be used by the inhabitants of the area and by other Contractors working in the limit of the Project area.

The Contractor shall be responsible for the maintenance of the roads and shall not make any obstruction to the traffic of any rubber-tyred vehicles of less than 14 tons per axle.

5.9.8 ASPHALT PAVEMENT ON CONCRETE STRUCTURES

The asphalt pavement on concrete structures shall be laid in accordance with standard procedure for an asphalt concrete surface course, it shall be composed as follows:

. A tack coat layer (250 g/m^2):

The material shall be cut back asphalt of medium curing rate MC 70 in accordance with ASTM D 2027. The concrete surface shall be cleaned by compressed air just prior spraying the tack coat.

. A perforated Kraft paper sheet (~5 g/m^2):

The tack coat layer shall be covered of perforated paper sheet, the percentage of perforation shall be fifteen per cent (15%).

. An asphalt layer (2 cm):

Immediately after covering with the perforated Kraft paper the asphalt shall be laid in a single course not less than 2 cm thick. It shall be pure asphalt used in Dampproofing and Waterproofing, type III, in accordance with ASTM D 449.

. A wearing course (5 cm):

It shall be of the same characteristics as the wearing course for roadway described in 5.9.1.

5.9.9 KERBING

When shown on the drawing or ordered by the Engineer kerbing shall be built as follows:

. On concrete structures

The precast concrete blocks shall be placed on a mortar bed, their dimensions shall be 15 x 35 x 66 cm and shall be provided with keys at their extremities.

. On embankment

- Supply and placing of a 10 cm concrete bedding on a compacted surface;

- Manufacture and placing of precast concrete blocks. Their dimensions shall be 15 x 25 x 66 cm and shall be provided with Keys at their extremities. Special curved kerbing elements shall be provided for curves and right angles.

5.9.10 PRECAST CONCRETE LATERAL PROTECTIONS

Along roadway on the closure dam, lateral concrete protections will be built as shown in drawing NE-29.

oOo

Division 6

CONCRETE

6.1 GENERAL

All concrete shall be composed of cement, fine and coarse aggregates, and water and whenever necessary, approved admixture.

6.2 PROPORTIONS OF CONCRETE

a) The concrete to be used will be divided into a number of classes. Each class will be designated by a compound reference number, the first number of which will specify the minimum weight of cement in kilogrammes per cubic metre of finished concrete. The second number will specify in millimetres the maximum size of aggregate to be used.

Thus concrete Class 300/50 (shown 300/50 on the drawings) will contain a minimum of 300 kilogrammes of cement to each cubic metre of finished concrete having a maximum aggregate size of 50 millimetres.

b) The following table sets out the nominal classes of concrete which may be used and on which the Contractor shall base his prices in the Bills of Quantities:

Nominal class of concrete * / **	Maximum water/ cement ratio	Minimum compressive and tensile strengths at 28 days	
		Compressive MPa	Tensile MPa
250/50	0.60	18	1.8
300/50	0.55	21	2.0
350/25	0.45	28	2.4
400/15	0.45	30	2.5
400/25	0.60	24	2.1

* Minimum weight of cement per cubic metre

** Maximum size of aggregates

6.1 GENERAL

All concrete shall be composed of cement, fine and coarse aggregates, and water and whenever necessary, approved admixture.

6.2 PROPORTIONS OF CONCRETE

a) The concrete to be used will be divided into a number of classes. Each class will be designated by a compound reference number, the first number of which will specify the minimum weight of cement in kilogrammes per cubic metre of finished concrete. The second number will specify in millimetres the maximum size of aggregate to be used.

Thus concrete Class 300/50 (shown 300/50 on the drawings) will contain a minimum of 300 kilogrammes of cement to each cubic metre of finished concrete having a maximum aggregate size of 50 millimetres.

b) The following table sets out the nominal classes of concrete which may be used and on which the Contractor shall base his prices in the Bills of Quantities:

Nominal class of concrete * / **	Maximum water/ cement ratio	Minimum compressive and tensile strengths at 28 days	
		Compressive MPa	Tensile MPa
250/50	0.60	18	1.8
300/50	0.55	21	2.0
350/25	0.45	28	2.4
400/15	0.45	30	2.5
400/25	0.60	24	2.1

* Minimum weight of cement per cubic metre

** Maximum size of aggregates

c) The actual water/cement ratio to be used in any particular case shall be submitted to the approval of the Engineer, but shall in no case exceed those given in the above table.

d) The actual proportion of coarse and fine aggregates will be determined from grading curves approved by the Engineer. The proportions may need to be modified from time to time to obtain a concrete of the optimum density, workability, consistency and strength with the specified water/cement ratio, and no claim will be contemplated in respect of such modifications.

e) Periodic tests will be carried out under the control of the Engineer to determine whether the gradings and proportions of the aggregates and the amount of cement and water used are providing a dense and watertight concrete of the required workability and strength. These tests will include determination of the percentage of voids in the concrete.

f) These tests will be made before commencing concreting operations and from time to time thereafter. The Contractor shall provide all materials and labour for these tests and shall include for their cost in his unit rates for concrete in the Bills of Quantities.

g) The nominal classes of concrete shown above may be modified by the Engineer, who can fix other cement contents than those stated above.

h) The nominal classes of concrete are shown on the Tender drawings.

6.3 MIXING OF CONCRETE

a) Arrangements shall be made for gauging the coarse aggregate, the fine aggregate, the cement and the water by weight, in an automatic type of weighing and batching plant or plants.

b) The different sieve separations of the coarse aggregates and the different types of fine aggregate shall be separately binned and the appropriate weight of each as determined by the Engineer added to each batch. The water content of the fine and coarse aggregate shall be determined regularly and the amounts of fine and coarse aggregates and water adjusted to maintain consistent concrete with a constant water/cement ratio.

c) The concrete mixing plant or plants shall be installed in suitable positions on the site to the approval of the Engineer and as near as possible to the place of deposit. Weighing of the cement is permitted to be non automatic if the amounts of coarse aggregate and sand in each batch are so arranged that one or more full bags of cement are used per batch. No subdividing of cement in bags will be permitted.

d) The concrete shall be mixed in batch or non-continuous machines of a type and capacity to the satisfaction of the Engineer and deposited as soon as possible after mixing.

e) Mixing shall continue at the approved speed for the particular machine for not less than the following periods after all the materials including the water have been passed into the drum and before any portion of the batch is discharged.

Capacity of mixer	Minimum duration of mixing
1.5 cu.m or less	2 minutes
Between 1.5 and 2.5 cu.m	2 1/2 minutes
Between 2.5 and 3 cu.m	3 minutes

f) The mixing time may be increased should this be necessary to ensure thorough mixing of the wet concrete, to the approval to the Engineer.

g) The methods of mixing used shall be such as to produce a dense homogenous concrete, and the order in which the concrete materials, comprising water, cement, fine and coarse aggregates, are to be fed into the mixer shall be subject to the approval of the Engineer.

h) The means of adding water to the materials shall be adjustable to compensate for the varying weight of moisture contained in the aggregates and for any change of mix proportions. The batching plant shall be capable of controlling the delivery of material so that the combined inaccuracies in feeding and measuring during normal operation will not exceed 1% in the case of water or cement or 2% in the case of both fine and coarse aggregates.

i) The Contractor shall provide standard test weights, at least equivalent to the maximum working load used on the most heavily loaded scale, and other auxiliary equipment required for checking the satisfactory operation of each scale or other measuring device. The accuracy of the scales shall be checked by test weights at least once a month and shall be carried out in the presence of the Engineer. Such tests shall be made whenever there are variations in properties of the fresh concrete which could result from batching errors. The Contractor shall furnish the Engineer with copies of the complete results of all check tests and shall make such adjustments, repairs or replacements as the Engineer may consider necessary to ensure satisfactory performance.

j) The batching plants shall be automatic and shall include:

- A wattmeter (slumpmeter) or any other approved concrete moisture content meter;
- A printing register recording the date and time of batching, the weight of cement, aggregates and water cement ratio.

k) The equipment for weighing the water to be used in a mix shall be provided with a safety device to prevent any possibility of spilling extra water into a batch once the required quantity has been added. After the concrete has been mixed no subsequent addition of water in the course of concreting will be tolerated.

l) The mixers shall be completely emptied before receiving the materials for the succeeding batch and shall be kept clean and shall be washed out after stopping work and at the end of each shift. On commencing work with a clean mixer the first batch shall contain only one-half of the normal quantity of coarse aggregate for the batch so as to compensate for the fine material and cement which is left adhering to the drum. This batch shall also be mixed for at least one minute longer than the normal time.

m) Complete records shall be kept by the Contractor of all concretings. The records shall contain details of time of mixing, casting, weather conditions, quantity, mixture proportions, amount of admixtures if any, slump and water content of each cast as well as the result of compressive tests on cylindrical test pieces and any other records required by the specifications. Records shall be kept of tests made on weight batching devices, scales mixers, cement and water control devices.

6.4 CONSISTENCY

a) The routine consistency test for all concrete shall be the slump test carried out in accordance with ASTM C 143. The Contractor shall provide the necessary number of slump cones and rods as required by the Engineer. The slump cones shall be designed to lift off in a truly vertical plane. Details of the proposed slump apparatus shall be submitted for the approval of the Engineer. No extra payment will be allowed for taking slump tests and the Contractor shall allow for these costs in his unit rates for concrete in the Bills of Quantities.

b) Slump tests shall be made daily at frequent intervals when concreting is in progress, as ordered by the Engineer. The first slump test shall be made immediately after concreting is commenced on any section. For the purpose of any test two slump tests shall be taken at a time and the average adopted.

c) The water/cement ratio shall be kept at all times as small as possible and shall not exceed the values specified. The water/cement ratio shall be strictly controlled in order to secure a concrete of uniform consistency. The quantity of water shall not be in such excess as to run off the surface in the process of consolidation and no bleeding shall appear on the surface of the concrete.

d) Any concrete containing aggregates exceeding 4 cm shall, for the purposes of slump test have such aggregate removed from the sample by wet screening or band picking. The Engineer reserves the right to require a lesser slump whenever practicable and wherever such lesser slump will produce a concrete of better quality.

e) The classes of concrete with regard to slump in centimetres are as follows:

Consistency	Nominal slump	Tolerance allowed limits*	Homogeneity Maximum differences between measures**
Very stiff	1 = 10 mm	0 - 2	1
Stiff	3 = 30 mm	2 - 4	2
Half plastic	5 = 50 mm	4 - 6	2
Plastic	8 = 80 mm	6 - 10	3
Fluid	16 = 160 mm.	14 - 18	4

* Taken as the average of 3 true slumps measured from a batching.

** Maximum difference between different true slumps measured from the same batching.

f) Concrete with the various classes of slump will generally be used as follows:

- 3 cm in heavy sections and at the top of walls, piers and parapets;
- 5 cm in slabs, and lightly reinforced sections;
- 8 cm in side walls and in heavily reinforced sections;
- 1 cm and 10 cm will generally be used only exceptionally;
- 16 cm is reserved for strip piles.

The Engineer reserves the right to prescribe different slump classes as the type of work may require in particular for prefabrication, etc.

6.5 TESTING CONCRETE

a) All cement and other materials shall be of such quality that when made into concrete on the Works the concrete shall attain the minimum strength specified.

b) Preliminary crushing tests (before commencement of concreting) and routine strength control will be made on 16 cm diameter cylindrical test pieces for concrete with aggregate up to 40 mm and 25 cm diameter test pieces for concrete with aggregate coarser than 40 mm.

c) The concrete shall be made from the materials to be used in, and to the exact proportions specified for the Works, and no concreting will be permitted until the results of these tests are available and have been approved by the Engineer.

d) Testing frequency will be as follows:

- Compressive strength tests:
  - one set for each concrete volume less than 50 m^3,
  - two sets for each concrete volume ranging between 50 and 250 m^3,
  - three sets of each concrete volume larger than 250 m^3,

a "concrete volume" being a structure or part of a structure concreted in one stage and in a single day with a given nominal concrete class.

One set includes six cylinders. Three will be tested at 7 days and three at 28 days.

. Spitting tensile strength:

Not less than 3 cylinders for each 1000 m^3 of concrete. Testing will be performed at 28 days.

e) The crushing strength measured at the various ages shall not be less than the strength specified multiplied by the ratio of the strengths at the given age and at 28 days, as measured on mortar cubes composed of 1 part cement and 2,75 parts by weight of graded standard sand and prepared and tested as per ASTM C 109.

f) A standard method of making and storing the specimens of concrete for compression tests shall be adopted as directed by the Engineer.

g) The Contractor, without extra cost beyond the rates generally quoted in the Bills of Quantities, shall provide twelve suitable and strong timber boxes lined with felt, the lids hinged and secured with padlocks and keys, for the safe transport of these cylinders, one per box, to and from the testing laboratory. He shall similarly provide 36 metal moulds for casting the cylinders in accordance with the standards set out below. No extra payment will be allowed in respect of labour and materials used in making, curing, handling and despatching concrete test specimens. The Contractor shall allow for these costs in his rates for concrete in the Bills of Quantities.

h) The metal moulds supplied for casting cylinders shall be approved by the Engineer. They must have machined faces and be of such a type that the concrete will be cast in a true and perfect cylinder and that the removal of the mould can be done without damaging the cylinder in any way. Each mould shall be provided with a heavy metal machined plate on which the mould shall be clamped or placed when casting the cylinder.

i) As often as the Engineer considers necessary, cores of 15 cm diameter of finished concrete shall be extracted so that samples of suitable dimensions can be cut therefrom. Coring and testing shall be carried out according to ASTM C42. Such sampling together with the filling-up of the resulting holes, shall be carried out at the expense of the Employer.

j) In the event of deposited concrete failing to set or harden normally, blocks shall be cut from it and tested. An analysis of the concrete shall also be made.Pending the receipt of the results of these tests the suspected concrete shall not be covered with fresh concrete. The entire cost of such tests shall be borne by the Contractor.

The required compressive strength of concrete fabricated shall be calculated according to ACI 318-77 Chapter 4.

k) Whenever points on the control charts approach the lower control limit an adjustment shall be made on the mix design.

Whenever one complete set of test specimens is outside of the specified value, in-situ tests such as sound velocity and coring shall be carried out at the expense of the Contractor. Whenever the in-situ tests confirm the results of the compressive strength test one of the following steps shall be taken at the Engineer's demand:

- Demolishing and reconstruction of the questionable part of the structure at the expense of the Contractor;
- Reinforcement of the questionable part of the structure at the expense of the Contractor;
- Rebate on the concrete price of the quantity of questionable work if in the Engineer's opinion this could be kept; the rebate will be left to the Engineer's discretion and will not be greater than 20%.

6.6 ADMIXTURES FOR CONCRETE

a) Admixtures such as Air-entraining, water-reducing retarding and non-shrinkage admixture will be used at the Engineer request. The admixtures shall comply with ASTM C 494 and shall be submitted to the Engineer for approval.

b) Trial mixes shall be made with the admixture and the job materials at temperatures and humidities anticipated on the job.

The amount of admixture shall be determined by laboratory tests and shall be submitted to the Engineer approval.

c) Provision shall be made in the batching plant for the addition of such material.

6.7 CONCRETE FOR CONSTRUCTION JOINT

If required by the Engineer the first layer of fresh concrete placed in hardened concrete shall consist of the same mix of the new lift without the biggest nominal size of coarse aggregates.

This layer shall be 15 cm thick.

6.8 PREPARATION FOR CONCRETING

a) At least two months before starting construction of a structure the Contractor shall submit for the Engineer's approval his proposed method of construction and programme of construction showing the general limit of excavation, the accesses to the different parts of structure, the method of shuttering, the main construction joints and the method of backfilling. The programme shall show the time of placing of the different lifts of concrete in relation with the backfilling programme.

b) Two weeks before any concreting is due to begin, the Contractors shall submit for the Engineer's approval their proposed methods for transporting and placing concrete and their proposals for construction joints (where not shown on the Drawings).

c) The Contractors shall give the Engineer at least 24 hours' prior notice of their intention to place concrete. Before any concrete is placed the Engineer will inspect the arrangements for transporting and placing concrete, the foundation, the formwork and the reinforcement (if any) and a sufficient time after the full completion of the relevant works shall be given to the Engineer to carry out this inspection before the approval to start concreting is given. Concrete placing shall not commence until the Engineer's approval has been given in writing.

6.9 CONVEYING CONCRETE

a) Concrete shall be transported from the mixer to its final position in such a manner that the concrete as placed shall not have lost excessive moisture or grout nor become segregated.

b) Concrete shall be placed and compacted in its final position within 30 mn of being discharged from the mixer unless special precautions have been taken by the Contractor with prior approval of the Engineer in each particular case.

c) Use of concrete pumps for transporting concrete may be permitted with the approval of the Engineer.

d) If chutes are used with the approval of the Engineer for conveying or placing concrete they shall not exceed 2 m in length. Their slope shall be flat enough to prevent aggregate segregating from the mix and if necessary the flow of the concrete shall be assisted by hand. A baffle shall be fitted at the tail of the chute to ensure that the concrete falls vertically from the chute. The chute shall be sheltered from rain and sun.

e) Concrete free fall greater than 1.5 m shall not be allowed.

.10 PLACING CONCRETE

a) The special case of strip piles concreting is covered in Section 11.

b) Concrete shall be placed and compacted in such a manner as to avoid displacement of formwork, reinforcement and other built-in items.

c) Concrete shall be deposited as near as possible to its final position; any local redistribution shall be made by shovel and not by pushing the material by vibrators or similar means. Any pockets of coarse aggregate shall be corrected by distributing the pocket throughout the mass and not by bringing other material to the pocket.

d) Within a lift the concrete shall be brought up in layers not exceeding 0.5 m in height for mass concrete and reinforced concrete, or as directed by the Engineer in special cases. Each layer shall be fully compacted before placing the succeeding layer.

e) As far as possible, the concrete of each layer within a lift shall be placed before the immediately underlying concrete of the preceeding layer has taken its initial set.

f) When a complete horizontal layer within a lift is not placed in one continuous operation (because of the requirements of sub-clause d) above or for any other reason), the layer shall be terminated against a vertical bulkhead. An 'operation' shall be considered as 'continuous' when carried out in such a time that initial set of concrete cannot occur.

g) Temporary breaks:

In the course of placing concrete it may become necessary by reason of an unavoidable breakdown of plant or for other reasons accepted by the Engineer, to interrupt concreting. On interruption of concreting the exposed surface of deposited concrete shall be protected fully from the sun.

If the concrete has taken its initial set but the period of interruption does not exceed 20 mn on resumption of work all laitance shall be cleaned from the surface of the deposited concrete and freshly mixed concrete shall be added immediately and thoroughly united with the old concrete. Coarser aggregate shall be omitted from the first layer of concrete placed and this layer shall not exceed 20 cm.

If the period of interruption does not exceed 4 hours on resumption of work the surface of the older concrete shall be wire brushed to roughen the surface and all loose material shall be removed. The fresh concrete shall be placed as previously described.

If the period of interruption is more than 4 hours but less than 28 hours, the surface of the older concrete shall be treated as a construction joint but use of a pneumatic hammer for scabbling will not be authorised.

In all case of previously agreed construction joints or temporary breaks and 24 hours before the new concrete is to be placed, the old concrete shall be washed and cleaned of any adhering deposits and loose particles of concrete. It shall be kept continuously damp, up to the time of concreting.

6.11 COMPACTING CONCRETE

a) This section does not apply to strip piles concrete.

b) All concrete shall be compacted with mechanical vibrators of the immersion type except for precast beams for which form vibrators may be used. The vibrators shall be of type and design approved by the Engineer. They shall operate at frequencies of not less than 10,000 impulses per minute.

c) The Contractors shall provide sufficient vibrators to compact each concrete batch thoroughly and immediately after it has been placed in the forms.

d) Vibrators shall be applied at the point of deposit and in the area of newly deposited concrete. They shall be applied in points uniformly spaced and not further apart than twice the radius over which the vibration is visibly effective. Vibrators shall be manipulated so as to work the concrete thoroughly around reinforcement and embedded items and into the corners of the formwork, but they shall not be used to make concrete flow over distances so great that segregation occurs nor to transport concrete in the forms. The vibration shall be of sufficient duration and intensity to compact the concrete thoroughly but shall not continue so as to cause segregation of concrete materials or laitance. Vibrators shall be inserted into and withdrawn from concrete vertically and slowly.

e) The vibrators shall penetrate the full depth of each concrete layer. Where the underlying layer is green concrete the vibrators shall also enter that layer and re-vibrate the two layers together.

f) Vibration shall be supplemented by such hand punning as is necessary to ensure the specified surface finish in locations impossible to reach with the vibrators. Punners shall be steel rods or timber sheathed in metal and bare timber rods shall not be used. Only blinding concrete may be worked and compacted by shovels and handpunners.

6.12 CONSTRUCTION JOINTS

a) The location of concrete construction joints, other than joints shown on the Drawings or specified, shall be approved by the Engineer; concrete shall be placed continuously between joints.

b) All construction joints shall terminate against firm shuttering. All necessary steps shall be taken by mean of timber edgings, etc., to ensure an exact finish to edges of joints which are exposed to view.

c) Before placing concrete against concrete which has already set at a construction joint, the surface of the previous concrete shall be prepared by the following methods. If the preparation is carried out before the previously placed concrete has hardened, the surface shall be cleaned with water and air at 0.5 MPa pressure to expose the coarse aggregate. If the concrete has hardened the surface shall be scabbled at least 2 cm deep and cleaned in such manner that no loose particles of aggregate or damaged concrete remain on the surface.

6.13 DEPOSITION OF CONCRETE ON FOUNDATIONS

The Contractor should keep free of running water and pools the surface of foundation. For deposition of concrete on an earth foundation, the Contractor shall use blinding concrete of class 250/25.

6.14 CONTRACTION AND EXPANSION JOINTS

a) Keyways and keys may need to be formed at contraction joints as directed by the Engineer.

b) Special types of fillers may be ordered by the Engineer to be placed in the joints.

c) Rubber waterstops shall be fixed with at least 5 cm clearance from any reinforcement bar, accurately positioned as shown on the Drawings and tightly fixed in the shutters before concreting starts. Connections shall be made to ensure watertightness and all precautions taken for careful concreting around waterstops. No nail shall be driven through any part of a waterstop for fixing. Any waterstop punctured or torn to any extent shall be replaced before concreting.

Shuttering of the first concreted surface of the joint shall be placed carefully perpendicular to the surface of the structure. Waterstops shall be placed carefully along a straight line and perpendicular to the surface of the joints, and/or according to the shape shown on the Drawings or instructions from the Engineer.

Particular care shall be taken with the protection of the outer part of waterstops half embedded in the structure and awaiting completion.

In the event of excavation in the vicinity of the waterstop of when more than one month elapses before completion of the structure, a protection device such as a wooden box shall be provided by the Contractor at his own cost. Rubber waterstops shall be stored in as cool a place as practicable and in no case shall they be exposed to the direct rays of the sun.

d) All joint implements such as waterstops, joint fillers, sealing compounds, etc. shall be handled and settled in accordance with the instructions given by the Manufacturer. All related notices and instructions shall be furnished to the Engineer in English prior to any approval being given.

e) Compressive filler (flexcell) when placed against concrete faces shall be fastened with adhesive before concreting of the next element.

6.15 CONCRETING IN HOT WEATHER

a) When day temperatures exceed 38°C, the Engineer may instruct that concreting be restricted to night work, unless he is satisfied that special arrangements have been made for mixing, placing and curing.

b) These special arrangements may include the use of ice in mixing water, sprinkling or covering the aggregates, wetting the wooden forms in advance of concreting, protecting concrete from high air temperature and drying winds by ponding, wet sand mat covering, or continuous water spray. In any cases the temperature of fresh concrete must be lower than 30°C at time of deposition, with exceptional tolerance to 32°C for limited volume.

c) The Contractor shall install at several points of the site as approved by the Engineer temperature recorders or maximum minimum thermometers protected by agreed sheds.

6.16 CONCRETING IN COLD WEATHER

Cancelled.

6.17 CURING OF CONCRETE

a) The exposed surfaces of newly placed concrete shall be cured by keeping it constantly damp for the following minimum periods:

- 14 days from November to April inclusive;
- 21 days from May to October inclusive.

b) The following curing methods will be acceptable subject to approval in each particular case by the Engineer:

- Covering with a layer of sand or earth (on top surfaces) sacking or similar absorbent material. The layer shall be kept continuously wet, water being sprayed on at intervals;
- Continuous spraying of the surface;
- After thoroughly wetting, covering with a layer of approved waterproof paper or plastic membrane;
- Applying a resinous curing compound, provided both the compound and method of application have been approved by the Engineer. This method of curing shall not be used on surfaces to which concrete is going to be subsequently bonded;
- Covering horizontal surfaces with ponded water to a minimum depth of 5 cm.

c) Water used for curing shall be free of salts in sufficient concentration to have a deleterious action on concrete after evaporation.

d) During the months from May to October inclusive, formwork shall be sprayed with water at frequent intervals from the time the concrete is placed until the formwork is removed. If formwork is left in place after concrete has set, the forms shall be loosened and the space between the form and the concrete wetted thoroughly at frequent intervals.

e) To avoid rust stains on the concrete, only galvanised, rubber or similar piping shall be used for all water spraying systems.

f) All materials and methods intended for curing concrete shall be inspected and approved by the Engineer before concreting is allowed to begin.

g) Blinding concrete shall be cured as shall any other class of concrete. Furthermore it shall remain protected up till the time the structural concrete is placed.

6.18 REPAIRS TO CONCRETE SURFACES

a) Defects appearing in concrete surfaces shall be made good by the Contractor as required by the Engineer. In case of serious defects, the Engineer may order the whole lift concerned to be removed and replaced.

b) Comparatively minor defects shall be repaired as directed by the Engineer. Methods or repair shall include:

- The defective concrete shall be cut out to its full depth. The width of the cut of full depth shall be not less than 4 cm and the sides of the cut shall be normal or nearly normal to the concrete face. After thoroughly cleaning and wetting the cut for an adequate period it shall be filled with an approved caulking compound. Alternatively, the cut may be filled with a stiff 400 or 500 kg per m^3 mortar or rich concrete containing an approved expanding or bonding agents. Filling shall be well hammered into the cut and cured as for concrete;

- Excrescences on the surface shall be rubbed down with carborundum brick or special concrete grinding tool. Any defects then appearing shall be repaired as specified above.

c) Neat lines left on concrete surfaces by construction joints will not be regarded as defects.

d) Temporary holes left in concrete surfaces for formwork supports shall be filled as specified in sub-clause b 1st point.

e) Rendering of concrete surfaces with a sand/cement mortar shall not be permitted except with special permission from the Engineer in exceptional cases.

6.19 Not used.

6.20 FINISHES FOR UNFORMED SURFACES

Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless the use of other slopes or level surfaces indicated on the execution drawings or directed, broader surfaces such as platforms and decks shall be sloped approximately 2 cm per metre. The following classes of finish shall apply to unformed surfaces.

a) Screeded finish (shown by SF on the drawings)

This finish applies to unformed surfaces that will be covered by fill material or concrete. This finish is also used as a first stage of floated finish. Finishing shall consist of sufficient levelling and screeding to produce even uniform surfaces.

b) Floated finish (shown by FF on the drawings)

This finish applies to the concrete surfaces of walkways and exposed decks or slabs. Floating may be performed by use of hand or power driven equipment. Floating shall be started as soon as the screeded surface has stiffened sufficiently, and shall be of the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities in floated finish shall not exceed 6 millimetres. Irregularities in excess of 6 millimetres shall be reduced by grinding so that they are within the limit. Joints and edges shall be tooled if directed by the Engineer.

6.21 SECOND STAGE CONCRETE FOR SEALING EMBEDDED PARTS OF EQUIPMENT

a) Concrete shall be of class 400/15. The workability shall be sufficient to ensure good pouring in the interstices of the first stage concrete.

b) A non-shrinkage admixture from an approved manufacturer shall be added. The admixture shall be mixed in accordance with the manufacturer's instructions. Tests shall be made before final approval can be given by the Engineer to adjust the amount of admixture to obtain effective non-shrinkage concrete.

Cast-iron powder admixture shall not be used in contact with high tensile steel and in direct contact with water.

c) For small holes (section less than 1 square dm), mortar shall be used. The mix shall be 450 kg of cement per cubic metre of sand with addition of an approved non-shrinkage admixture.

d) Formwork shall be perfectly connected with first stage concrete: irregularities shall be made good by means of grinding.

6.22 PRECAST CONCRETE

Slabs, kerb, sidewalk cantilever, guidewall crest beams, staircase shall be made of concrete class 350/25.

In case of thin elements, thickness less than 15 cm, precast concrete shall be made of concrete class 400/15.

oOo

Division 7

FORMWORK

7.1 SHUTTERING AND FORMWORK

a) All shuttering and formwork, falsework supports and scaffoldings stagings shall be to the approval of the Engineer and shall be of sufficient strength and stiffness to support the fresh concrete without appreciable yielding when such concrete is subjected to heavy working, vibrating and ramming. If steel shuttering is used for any structure exposed to the sun, the shuttering shall be adequately protected from the sun to the satisfaction of the Engineer.

b) No timber less than 2.5 cm thick shall be used except with the approval of the Engineer. All joints in shuttering shall be close fitting to avoid loss of fine materials or mortar during the placing and consolidation of the concrete.

c) The designs of all shuttering and formwork as well as the type of fixing shall be submitted to the Engineer for his approval before proceeding with the manufacture thereof.

d) Shuttering intended for work that is to be permanently visible shall be smooth and all shuttering shall, before use, be thinly coated with shutter oil or other approved material to prevent adhesion of the concrete thereto. Care shall be taken to keep the steel reinforcement free from any such coating material. In working the green concrete against the shuttering the greatest care shall be taken so that when the shutter is removed a perfectly smooth surface requiring no rendering whatsoever is obtained. Should there be blemishes, however, the Contractor shall cut out and replace the work or make good if permitted by the Engineer and in the manner prescribed by him. Rubbing down shall be done to the Engineer's approval.

e) All exterior angles in exposed work shall be given chamfers 2 cm x 2 cm, without extra payment. Cores or other devices for forming holes, chases, etc shall be in position in the shuttering as far as possible. The Engineer's approval will be required before cutting into any concrete work subsequently.

f) Prior to any successive utilisation the shuttering shall be thoroughly cleaned from laitance and other materials. Shuttering shall be fixed on the concrete layer existing just below the concrete layer to be cast and shall include temporary openings in order to permit a complete final cleaning of the construction joint. All care shall be taken when placing the shuttering not to displace, deform or injure the reinforcement bars.

g) All formwork shall be designed to withstand the following loads, unless special justification is given by the Contractor and agreed by the Engineer:

- The dead load of the concrete and embedded items if any.
- A live load of 250 kg/m^2 on the whole area of horizontal formwork or the load of a bucket of concrete, whichever introduces the greatest stresses.
- Horizontal forces due to wind of 90 kg/m^2.
- Pressure of green concrete taken as the smaller of the two values:
  - P = h x 2.4 in tons/square metre
    where h in metres being the head of green concrete
  - P = a + b.V
    where V = rate of filling in metres per hour

The values a and b are as follows:

Temperature of concrete	Rate of filling (V m/h)	
	Less than 2 m/h	More than 2 m/h
Less than 5°	2 + 1.25 V	4.1 + 0.2 V
5° to 25°	2 + 1.00 V	3.6 + 0.2 V
More than 25°	2 + 0.85 V	3.3 + 0.2 V

The spacing support for sheeting shall be such that deflection of the sheeting under the superimposed load shall not exceed three millimetres at any point.

If necessary the formwork will be fitted up with counter deflection.

The formwork and falsework shall be fabricated in sections of suitable size so that erection and striking may be performed easily and without any risk to the concrete in place.

7.2 STRIKING SHUTTERING AND FORMWORK

The shuttering and formwork shall not be struck before the Engineer's approval has been obtained but under normal conditions the minimum intervals that shall elapse between the completion of concreting and removal of shuttering will be as follows:

- Walls and sides of beams: 48 hours;
- Soffits of slabs and beams: 14 days or whenever possible more.

The Contractors shall take full responsibility that sufficient time has elapsed for the concrete to attain ample strength before shuttering is removed.

7.3 FASTENING AND FIXING SHUTTERING

a) Fastening bolts for fixing formwork shall fit on nuts embedded in the concrete and their centre line shall always be normal to the shuttered surface of the concrete.

b) Exceptional use of wire or rod ties or stays or special supports embedded in the concrete shall require previous permission of the Engineer in each particular case. Such devices, if exceptionally authorised by the Engineer, shall be cut after removal of the shuttering at a depth not less than 5 cm from the shuttered surface and the relevant holes shall be filled with epoxy mortar in accordance with the Engineer's instructions.

c) In all cases, holes left in the concrete by fasteners shall be of regular shape and completely filled with epoxy mortar or grouted to the satisfaction of the Engineer.

7.4 CURVED FORMWORK

Curved formwork is that with a radius less than 5 m. All the formwork with a radius greater than 5 m is considered as straight shuttering.

Formwork for curved surfaces with a radius less than 2 metres shall be truly formed to the specified curve. Unless otherwise specified formwork for curved surfaces of radius of 2 m or greater may be formed of a series of chords provided the length of each chord does not exceed one twentieth of the radius specified.

7.5 TOLERANCES CONCERNING THE QUALITY AND SETTING-OUT OF SHUTTERING OF FORMWORK

a) Shuttering or formwork is divided into a certain number of classes as regards the tolerances and finish of the surfaces and in accordance with the definitions as follows:

'Local irregularity' means a local irregularity resulting from displacement, wrong setting-out, unsatisfactory surface conditions of the shuttering or from any other causes.

'Gradual irregularity' refers to any other difference between the theoretical and the actual lines of the concrete face. However gravel pockets and loss of laitance, in particular at bonds between concrete layers, are not considered as irregularities but as defects to be made good as specified under clause 06.18.

b) Measurement of the irregularities is taken as follows:

- local irregularities - Direct measurement;
- gradual irregularities - By means of a rule for plane surfaces and of an appropriate template for curved surfaces. The length of the rule or template shall be 1.50 m.

c) The different classes are as follows:

Class I (shown by Δ on the drawings)

Concerns generally surfaces and joints which do not require a special finish.

Maximum permissible irregularities:

Local irregularities	5 mm
Gradual irregularities	12 mm

Irregularities in excess to the figures above shall be cut out and ground to the specified tolerances.

Class II (shown by Δ Δ on the drawings)

Concerns normally weirs, sills, spillways, hydraulic conduits, intakes and outlets and any surfaces specified by the Engineer.

Maximum permissible irregularities:

Local irregularities	3 mm
Gradual irregularities	6 mm

All local irregularities exceeding the above figure shall be ground to their full depth to form a chamfer not exceeding 1 in depth to 50 in length.

Gradual irregularities in excess to the figure above shall normally be made good by means of cutting and grinding. In no case, rigging of surfaces along which water flows at a velocity over 7 m/s will be permitted. However the Engineer may, in certain case, permit that such surfaces when they cannot be made good by means of cutting and grinding, be repaired with epoxy resins. Repairs with resins shall then be carried out by approved specialists.

Class 0 (not shown on the drawings)

Concerns normally foundations, construction joints and the like, shuttering of surfaces to be coated with mortar or the like, etc. for which no limiting tolerances are established in respect of irregularities.

[illegible] shall [illegible] in the
[illegible] in t[illegible] [illegible]ected by

[illegible] the diffe[illegible] actual
[illegible] of any [illegible] shall

[illegible] concrete [illegible] [illegible]rfaces
[illegible] wherever sp[illegible] [illegible]ineer;

[illegible]rete.

[illegible]kness of the [illegible] [illegible]ss than
[illegible]wings.

[illegible] which will [illegible] [illegible]atings

[illegible] shall not ex[illegible] [illegible] local
[illegible] rubbed down [illegible] [illegible] visible

[illegible] panels and b[illegible] [illegible]nsidered
[illegible] arrangements [illegible] approved

[illegible] of structures [illegible] [illegible]sed to

[illegible] misalignment [illegible] [illegible] be
[illegible] of the formwo[illegible] [illegible] in an
[illegible] with joi[illegible] [illegible] or
[illegible] accurate [illegible] [illegible] plane of
[illegible] approved shall [illegible] [illegible] uniform
[illegible] of the sheeti[illegible]

[illegible] shall be [illegible] [illegible] with
[illegible] obvious feat[illegible] [illegible] to the
[illegible]

[illegible] the rain, [illegible] [illegible] shall be
[illegible] the risk of [illegible] [illegible] marks by

[illegible] of a y defe[illegible] [illegible] [illegible] areas
[illegible] be f lled [illegible] [illegible] striking.

[illegible] shall be remove[illegible]

[illegible] will be [illegible] [illegible] counter
[illegible] the drawi[illegible] [illegible] the

d) In all cases, the shuttering shall be set out accurately in the positions and locations shown in the Drawings or as directed by the Engineer.

Unless otherwise specified the difference between the actual and the theoretical position of any point at the surface shall not exceed:

- 1 cm for reinforced concrete structures, for surfaces subject to flow and wherever specified by the Engineer;

- 3 cm for mass concrete.

In no case shall the thickness of the structure be less than the one shown on the drawings.

e) For surfaces of structures which will receive paint coatings

Gradual irregularities shall not exceed 6 mm and all local irregularities shall be rubbed down in order to not be visible after coating.

Regular joints between panels and boards will not be considered as irregularities if the arrangements are previously approved by the Engineer.

f) For Class II formwork of structures prominently exposed to public view:

No offsets, bulges or misalignment of concrete shall be visible. The sheeting of the formwork shall be arranged in an approved uniform pattern with joints truly vertical or horizontal so as to afford accurate alignment in the plane of sheets. Form ties if approved shall be disposed in a uniform way inside the pattern of the sheeting.

The position of the joints shall be chosen to coincide with architectural or other obvious features and submitted to the approval of the Engineer.

For elements exposed to the rain, recessed joints shall be provided so as to reduce the risk of stains and dirty marks by weathering agents.

The finish shall be free of any defects other than small areas of air holes which shall be filled immediately upon striking.

All accidental stains shall be removed.

If necessary the formwork will be fitted up with a counter deflection when shown on the drawings or required by the Engineer.

7.6 TOLERANCES CONCERNING THE FINIS , POSITION AND LOCATION OF NON SHUTTERED FACES

a) Where floated finish (FF on the drawings) is specified, it means that the face shall have no irregularities in excess to those permitted for Class II shuttering.

b) Where floated finish is not specified the finish shall conform to the requirements as for Class I shuttered face except where concrete is to be covered by fill or backfill.

c) The provisions of Clause 07.05 d) shall apply to non shuttered faces.

oOo

Division 8

REINFORCEMENT

8.1 BENDING OF REINFORCEMENT BARS

a) Reinforcement shall be accurately formed to the dimensions indicated on the Drawings and in strict compliance with the bar bending schedule. Bars shall be bent around a pin having a diameter not less than six times the minimum thickness, except for bars larger than 25 mm in which case the bars shall be bent around a pin of eight bar diameters. Alternatively bars may be bent with the use of an approved bending machine. Unless otherwise permitted by the Engineer, all bars shall be bent cold.

b) Reinforcement shall not be straightened or rebent in a manner that will injure the material process which shall be strictly forbidden for deformed bars. Bars with kinks, or bends not shown on the Drawings, shall not be used. Heating of the reinforcement will be permitted only when the entire operation is approved by the Engineer.

c) The deformed bars shall be used mainly except specified otherwise.

8.2 PLACING REINFORCEMENT

a) Concrete reinforcement, before being positioned, shall be free from loose mill and rust scale, oil, grease and from coatings that destroy or reduce the bond. Where there is delay in depositing concrete, reinforcement shall be reinspected and cleaned when necessary.

371

b) Reinforcement shall be accurately positioned and secured against displacement by using annealed iron wire ties or suitable clips at intersections, and shall be supported as required by concrete or metal supports, spacers or metal hangers. In all case sufficient supports for horizontal reinforcement shall be used so that there will be no sagging of the bars or mesh. Where portions of the supports will be exposed on concrete surfaces designated to receive a smooth finish the supports shall be made of non-corrodible metal.

c) Reinforcement in slabs on the ground shall be supported by means of precast concrete blocks. The concrete blocks shall have a horizontal surface approximately 7 cm by 10 cm. The reinforcement in all other slabs and in beams shall be supported by means of metal chairs.

d) The minimum centre-to-centre distance between parallel bars shall be two and one-half times the diameter of the bars, but in no case shall the clear spacing between the bars be less than one and one-half times the maximum size of the coarse aggregate.

For hydraulic structures, the clear distance between parallel bars should not be less than 1-1/2 times the nominal diameter of the bars nor less than 1-1/2 times the maximum size of coarse aggregate. When parallel reinforcement is placed in two or more layers the clear distance between layers should not be less than 15 cm.

e) Concrete Protection for Reinforcement: The minimum cover for principal reinforcement should conform to the dimensions shown in the table below for the various concrete sections. The dimensions indicate the clear distance from the edge of the main reinforcement to the concrete surface. The concrete covering of stirrups, spacer bars and similar secondary reinforcement may be reduced by the diameter of such bars.

. Sections exposed to action of water, other destructive agents, or severe impact or abrasion or contact with foundation:

Unformed surfaces	10.0 cm
Formed and screeded surfaces	7.5 cm

. Non-massive sections; including building exteriors:

Exposed to atmosphere	4.0 cm

. Interior concrete surfaces ———— 2.5 cm

f) When it is necessary to splice reinforcement at points other than shown on the Drawings, the character of the splice shall be submitted to the agreement of the Engineer. In principle minimum length of lap for tension and compression lap slices shall comply with ACI 318-77.

g) Rust that cannot be removed by firm rubbing with burlap will not be considered objectionable and will not be removed.

h) During the earliest stage of hardening after the concrete has lost its plasticity, reinforcement shall not be subject to impact or rough handling. Workmen shall not be permitted to climb on bar extensions until the concrete is at least 7 days old.

8.3 WELDING OF REINFORCEMENT

Where shown on the drawings or specified or directed by the Engineer mild steel reinforcing bars shall be butt welded. Butt welding shall be performed in strict compliance with the instructions of the Engineer by properly qualified and experienced welders, and shall comply with AWS D 12.1.

8.4 BAR SIZES

- Reinforcing bars are detailed in metric sizes. Nominal diameters in mm are normally as follows :

  6 - 8 - 10 - 12 - 16 - 20 - 25 - 32 - 40

- The Contractor may substitute for any metric diameter the inch diameter immediately superior.

- No alteration to the spacing or number of bars, nor to the measurements of the weights in the Bill of Quantities will be allowed if inch sizes are used instead of metric sizes.

oOo

Division 9

PLASTIC CONCRETE DIAPHRAGM WALL

9.1 GENERAL

9.1.1 WORKS TO BE PERFORMED

The works to be carried out include:

- Construction of the permanent plastic concrete diaphragm wall under concrete structures, through the closure dam and through the river banks as shown in drawing NE-30;
- Construction of the watertight seal (key trench) in plastic concrete at the contact with the rafts of concrete structures as shown in drawing NE-30;
- Construction of a watertight vertical junction between power plant and concrete connecting structure lock/power plant. The Contractor will make a detailed proposal to the Engineer for construction of this item;
- Construction of a watertight vertical junction between spillway right end and closure dam diaphragm wall. The Contractor will make a detailed proposal to the Engineer for construction of this item.

9.1.2 APPROVAL OF THE CONTRACTOR

Only specialised Contractors with at least 15 years' experience of the same type of works can be approved by the Engineer. The supervisor responsible for the works must have at least 10 years' experience in this speciality.

9.1.3 STANDARDS AND CODES

A. Standards

The applicable standards will be those of Division 01.

B. Codes

The applicable code shall be the code of practice for foundations CP 2004.

9.1.4 DOCUMENTS TO BE SUPPLIED BY THE CONTRACTOR

A. Documents justifying capacity to build the diaphragm wall

These documents shall be submitted to the Engineer's approval at least one month before the start of works. They shall include all relevant information pertaining:

- to the equipment used,
- to the technical experience of the Contractor and his personnel.

B. Cement, bentonite, clay and possible additives

- Certificates of approval of materials;
- Chemical and physical analyses;
- Record book of inward and outward movements of materials at the end of each week.

C. Diaphragm wall excavation mud

- Study of mud characteristics;
- Results of control tests.

D. Plastic concrete

- Programme of design and suitability tests;
- Results of design and suitability tests;
- Results of control tests.

E. Drawings of low guide walls

Guide for the information of the Engineer.

F. Detailed proposal for construction of vertical junctions

As required in § 9.1.1.

G. Programme of works

The detailed programme of works on the diaphragm wall shall be supplied at least two months before the start of the corresponding works.

H. Daily statements

The Contractor shall submit to the Engineer, within a period of 24 hours, the daily statement giving full details of the works completed during the day:

- Materials used;
- Volumes excavated;
- Concrete placed;
- Samples removed and tests performed.

Generally speaking, the tests results shall indicate:

- Sample identification number;
- Origin of sample;
- Part of the structures represented by the sample;
- Date of sample removal;
- Description of test with reference to a standard;
- Test result;
- Date of test;
- References of laboratory performing the test.

9.1.5 LABORATORY

The Contractor must have on site and in his laboratory the equipment necessary to measure the mud characteristics at all times, as well as the sampling equipment necessary to take mud samples from the trench.

9.2 PRODUCTS

9.2.1 CEMENT, WATER AND POSSIBLE ADDITIVES

These products shall conform to the specifications, Division 4.

9.2.2 BENTONITE

The bentonite shall have a plasticity index greater than 250.

The bentonite in suspension in the water must contain no particle larger than 0.080 mm.

The bentonite must be free of any particles which might be prejudicial to hardening of the concrete.

A. Bentonite for mud without cement

The bentonite supplier must guarantee a figure (expressed in grams per litre of water) corresponding to the maximum mass of bentonite that must be added to one litre of water to give a mud with a 40 seconds Marsh viscosity value. This figure is referred to as the dosage.

B. Bentonite for mud with cement

The specification is similar to that in A. above, except that 200 g of cement per litre of water are added to the bentonite.

The bentonite shall be supplied in sacks which shall be stored under the same conditions as the cement sacks.

9.2.3 CLAY

The clays to be used shall be defined in detail by the Contractor, who shall specify the following:

- Origin;
- Treatment;
- Characteristics;
- Conditions of supply and storage.

9.2.4 OTHER PRODUCTS

Any additive which it may be proposed to use will have to be approved by the Engineer after laboratory tests have demonstrated its advantages.

The use of any product the chemical composition of which is unknown or kept secret shall be forbidden.

9.2.5 MUD FOR EXCAVATION

The excavation mud is a mixture of water, bentonite, possibly clay, additives and cement, if any. The mud must be suitable for maintenance of stability of the faces of the trench during its excavation until completion of concreting, and must be such as to allow concreting under satisfactory conditions.

The characteristic variables of a mud are:

. density,

. viscosity measured by Marsh cone (base 1 litre),

. sand content,

. filtrate,

. cake thickness.

Filtrate and cake will be measured with Baroid devices for a pressure of 7 bars applied for 30 mn.

A newly mixed mud, before use, must have the following characteristics:

. Density in the range of 1.01 to 1.05 (except in the particular case of a weighted or clayed slurry);

. Marsh viscosity greater than 35 seconds;

. Zero sand content;

. Filtrate less than 30 m^3 (in case of slurry without cement);

. Cake thickness less than 3 mm (in case of slurry without cement).

The mud recovered during excavation works may be re-used after appropriate treatment. This treatment must give the mud the following characteristics:

. Density less than 1.20 (except for weighted slurry);

. Marsh viscosity between 35 and 90 seconds;

. Sand content of the order of 5%;

. Filtrate less than 40 m^3 (in case of slurry without cement);

. Cake thickness less than 5 mm (in case of slurry without cement).

In the event of cement being added, the figures for filtrate and cake should be as follows:

. With a mix of 100 kg/m^3 of cement and 50 kg/m^3 of bentonite:

- filtrate: less than 300 cm^3,
- cake thickness less than 40 mm.

. With a mix of 5 kg/m^3 of cement and 50 kg/m^3 of bentonite:

- filtrate: less than 100 cm^3,
- cake thickness less than 10 mm.

The mud shall be the subject of a study to be carried out by the Contractor before any work is started.

This study shall indicate:

. the formulation,

. the desired characteristics,

. the results of tests carried out on site with the specified materials.

9.2.6 PLASTIC CONCRETE

9.2.6.1 Characteristics to be obtained

. Simple compressive strength at 28 days not greater than 1.2 MPa and not less than 0.8 MPa.

. Modulus of elasticity between 50 and 300 MPa within the range of deformation 0-0.5% at 28 days (velocity of deformation of the order of $2.5\ 10^{-5}$ per minute), measured during the test of simple compressive strength.

. Permeability measured in the laboratory: less than 10^{-8} m/s. This figure corresponds to the target, but in any event permeability shall never be greater than 5×10^{-8} m/s.

. Plasticity: the value of this characteristic shall be proposed by the Contractor to the Engineer for approval, and will depend on the working conditions and equipment used.

. Viscosity of bentonite water and cement mix, if any: 50 to 55 seconds Marsh.

9.2.6.2 Plastic concrete composition

The plastic concrete shall in principle be constitued by a mixture of cement, bentonite, clay, sand and gravel of maximum size of 20 mm.

9.2.6.3 Design test

The study will be based on performance of the following tests:

. Slurry, if any, resulting from the mixture of water, clay, bentonite and cement intended for use in the concrete mix:

- Density after settling;
- Setting time;
- Viscosity;
- Compatibility of cement, bentonite, clay and possible additives.

. The concrete itself:

- Simple compressive strength and modulus of elasticity;
- Permeability;
- Slump test.

The study will be carried out for different slurry compositions (a minimum of six), derived from the nominal formula, with a view to showing the sensitivity of concrete characteristics, according to the cement proportions in particular.

9.2.6.4 Suitability trials

These trials, to be undertaken on site at least 40 days before the start of concrete manufacture for the permanent diaphragm wall, will be aimed at verifying the following factors:

- Conformity to specifications of the plastic concrete manufactured by application of the nominal composition, using the materials supplied to the site;
- Suitability of the concrete composition for building the wall under satisfactory conditions, taking into account the envisaged plant;
- Conformity of the material characteristics to those of the material submitted to the Engineer's approval.

The suitability trials, to be conducted under representative site conditions, will involve the preparation of three mixes according to the nominal composition, and will consist of the following operations:

- Construction of a trial diaphragm wall;
- Removal of samples and performance of the same tests as stipulated under design tests;
- Verification of characteristics of the site installations and supplied materials.

9.2.6.5 Fabrication

- In the event of concrete being made from bentonite slurry (mixing slurry and aggregates), the minimum duration of hydration of the bentonite before it is mixed with the cement shall be 4 hours. The site installations shall be designed in consequence.

  If the Contractor proposes to use a special technique to reduce this minimum duration of hydration, he must first present a justification of this technique to the Engineer for approval and conduct a full-scale trial for demonstration.

  The plant used must be such as to ensure perfect mixing of the bentonitic slurry with the other materials.

- In the event of concrete fabrication in one phase, the hydration time must be shorter, and must be evaluated by testing directly after mixing.

9.3 EXECUTION

9.3.1 TEST WALL

. After approval by the Engineer of the results of the study of plastic concrete, the Contractor will build a tests wall of minimum length 18 m at a location on the site determined by the Engineer. The penetration of the test wall in the hard clay layer will be 2 m.

. The Engineer will define the tests and works necessary for observation of the test wall when it has been completed.

Control core samples may be taken to check the homogeneity of the plastic concrete and continuity of the joints; permeability tests shall be performed.

Two inclined core samples may be effected down to the bottom of the wall to check that the alignment and dimensions conform to the Engineer's specifications.

9.3.2 CONSTRUCTION PHASES

The construction phases for diaphragm wall under concrete structures will be as follows:

. Building of guide walls;

. Excavation and concreting of plastic diaphragm;

. Demolition of guide walls, excavation of key trench;

. Construction of the two concrete beams;

. Diaphragm wall head cut-off in order to have the top of diaphragm 0.50 m above key bottom elevation;

. Pouring of the plastic concrete in the key trench.

9.3.3 REQUIRED PENETRATION IN HARD CLAY LAYER

The required minimum penetration of the diaphragm wall in the hard clay layer is 2 m, the elevation of the top of the hard clay layer being determined during the geotechnical investigations specified in Division 02.

Locally this penetration could be increased at the request of the Engineer.

9.3.4 INSPECTION

Excavation of the slurry trench shall not be begun before acceptance by the Engineer of the working platform and low guide walls.

No concreting for the diaphragm wall shall be undertaken until issue by the Engineer of an 'authorisation to concrete'. The Contractor shall ask for this authorisation at least 4 hours before the presumed beginning of concreting and after inspection and verification of the slurry trench by the Engineer.

9.3.5 GUIDE WALLS

The Contractor shall build guide walls designed to guide the excavation plant. The shape and dimensions of the guide walls will depend on the working method, and the Contractor shall present a justification of the proposed shape and dimensions to the Engineer for information.

The Contractor shall make all necessary arrangements to ensure stability of the walls, if necessary by supports. He shall also take care to avoid any penetration of slurry around the walls, so as not to cause breakage or sliding of same.

9.3.6 EXCAVATION

The trench shall be excavated by means of a grab, in successive panels. The panels shall be between 6.50 and 7.50 m in length, except in special cases to be approved by the Engineer.

The secondary panels shall be excavated with an overlap of 0.50 m into the adjacent primary panels, but only when the primary panels have sufficient resistance.

On completion of excavation of the secondary panels, the Contractor shall ensure that the totality of each of the earth mounds separating the primary panels has effectively been removed. To this effect, he shall 'sweep' with the grab the bottom of the trench throughout the length of the secondary panel concerned.

The excavated material must be deposited in such a manner as to avoid any risk of sliding or infiltration of the material into the trench.

The level of mud in the trench must at all times be situated at least 1.50 m above the level of the aquifer which any exist in the area of excavation.

Any sudden or abnormal drop in the level, indicating a mud loss, must be notified immediately to the Engineer.

9.3.7 CONCRETING OF THE DIAPHRAGM WALL

9.3.7.1 The trench shall be cleaned less than 3 hours before concreting is started, and the mud characteristics shall be checked.

The characteristics of the mud at the bottom of the trench shall be measured after clearing of the said trench, and noted on the test report sheets. These characteristics must be at least those given above for treated recycled mud.

If preparation of the plant implies a longer duration, a mud sample shall be taken from the bottom of the trench when the plant is ready. If the mud characteristics are satisfactory, concreting can begin. Otherwise, complementary recycling treatment must be effected until the right characteristics are obtained.

9.3.7.2 The plastic concrete will be place by means of a concreting column, consisting of a steel tube made up of a number of sections, topped by a funnel or discharge chute. The joints between the sections must be watertight. The internal diameter of the column shall be equal to at least 4 times the diameter of the aggregates in the concrete to be placed, and never less than 15 cm. The external diameter shall be less than half the width of the trench.

The height of the concreting column is equal to the depth of the trench. Before concreting, the column is lowered to make contact with the bottom, then raised by a maximum of 15 cm. Priming (or the first pouring of concrete) must be effected in such a way as to avoid contamination of the concrete by the mud contained in the column, by means of a temporary plug forced down through the column by the concrete. After priming, the base of the column must never be less than 3 m below the level attained by the fresh concrete in the trench.

9.3.7.3 The Contractor shall take all necessary precautions during hot weather, particularly concerning the risk of drying of the concrete.

On completion of construction of each panel, the Contractor shall protect the top of the wall by placing a 2.00 m wide sheet of polyurethane covered by a temporary layer of fill 0.50 m thick.

تطلق هذه اللفظة الانجليزية على اللوح الذى
تزيد تخانته عن ٠,٠٦ بوصة ولا يتعدى ٣/٨ بوصة
ويزيد عرضه عن ١٨ بوصة

9.3.8 KEY TRENCH UNDER CONCRETE STRUCTURES

Excavation shall be completed by hand, so as to remove all uncompacted soil from the slopes and from the bottom of the trench.

The concrete beam surfaces shall be cleaned to eliminate all traces of earth, laitance and pieces of loose concrete. If necessary the concrete surfaces must be brushed and hammered to make them rough. These surfaces shall be maintained wet before concreting.

The head of the diaphragm wall shall be cut-off to the required elevation and the lateral faces of the part protruding above key trench bottom shall be hammered to make them rough. These surface shall be maintained wet before concreting and protected with sheets of polyurethane.

All necessary precautions shall be taken to avoid drying out of the soil after excavation and before concreting.

Immediately on completion of concreting, the concrete shall be protected as indicated under § 9.3.7.3 above for the diaphragm wall concrete.

9.3.9 DIAPHRAGM WALL CONSTRUCTION TOLERANCES

- Alignment on plan relative to theoretical centre lines: $\pm$ 0.20 m;
- Verticality: 2%;
- Width: not less than the specified value of 0.80 m;

The procedures for measurement of verticality and width of the trench shall be submitted to the Engineer's approval.

9.3.10 CHECKS

A. Excavation of the trench

Each panel shall be checked before concreting.

B. Excavation mud

- Composition, viscosity and density: several times per day;
- Sand content: just before pouring the concrete;
- Filtrate and cake: during the study of slurry characteristics, and then from time to time during the works.

C. Plastic concrete

Samples of plastic concrete shall be taken from the mixing plant for the purpose of the following tests and measurements:

- Plasticity tests;
- Compressive strength tests;
- Elasticity modulus measurements;
- Permeability measurements.

The samples shall be moulded in PVC tubes, completely sealed and preserved by immersion in water at 28°C for 7 days and 28 days.

From each sample removed, three moulds shall be made.

The following tests shall be undertaken:

- Plasticity;
- Simple compressive strength tests at 7 and 28 days and measurement of elasticity modulus;
- Permeability measurement (on about 10% of the moulded samples).

D. Characteristics of products

Characteristics of bentonite, clay, cement, aggregates, etc. shall be checked from time to time and in any case once for each lot.

oOo

م/ محمدی عباس

Division 10

STRIP PILES

10.1 GENERAL

10.1.1 APPROVAL OF THE CONTRACTOR

Only specialised contractors with at least 15 years experience of the same type of works can be approved by the Engineer. The supervisor responsible for the works must have at least 10 years experience in his speciality.

10.1.2 STANDARD

The calculations and the works are to be executed in accordance with the French DTU 13/2 Deep foundations (June 78 amended and commented in November 78 and September 82) and more especially its Chapter 4: 'Bored piles under bentonitic mud'.

The following requirements are mainly based on this document.

When the present specification and DTU 13/2 are conflicting, the present specification will prevail. For points not covered by the present specification, DTU 13/2 will be followed.

10.2 DESIGN AND CALCULATIONS

10.2.1 GENERAL

Based on the allowable soil data and for quantities evaluation purposes, the following preliminary design was adopted:

- Strip pile section: 1.7 m^2;
- Pile tip: elevation 49;
- Average concrete vertical stress: 3.5 MPa.

A detailed design will be performed by the Contractor after the complementary site investigation. The effect of seismic loading and the liquifaction, if any, of the loose sands will be considered in the design.

10.2.2 STRESSES IN CONCRETE

Maximum allowable compressive stress under first kind loads as defined in DTU 13-2: 5 MPa for the specified concrete. Other stresses in accordance with DTU 13/2. Maximum stresses in concrete can be limited by maximum soil bearing capacity.

10.2.3 SOIL BEARING CAPACITY

Calculated in accordance with DTU 13/2, Chapter 11, September 83 based on static cone penetration test results (CPT) or pressuremeter tests if the later are available before detailed design.

10.3 TOLERANCES ON PILES LAYOUT

- In the horizontal plane: 6 cm
- Out of plumb: 2% of pile length

10.4 PLATFORM ELEVATION

The platform elevation will be set at + 65.

Cut off of the pile head will be performed until elevation + 64.05.

10.5 EXCAVATION UNDER BENTONITIC MUD

10.5.1 GUIDE WALLS

The upper part of the excavation is to be protected by concrete guide walls or steel shuttering to prevent the collapse of the top soils. The minimum depth of this protection is 0.80 m.

10.5.2 MUD

10.5.2.1 Mud level

The mud level will be at least 1.5 m above the level of the ground water during excavation.

10.5.2.2 Mud characteristics

The drilling mud will be a water bentonite mix with additives if necessary. The required mud characteristics are:

. New mud, before use:

- density: 1.01 to 1.05;
- marsh viscosity: larger than 35 s;
- sand content: 0;
- cake thickness: less than 3 mm;
- volume of filtered water after 30 min under 7 kg/cm^2 in the Baroid equipment: less than 30 cm^3.

. Mud can be recycled during excavation in order to be reused

The required mud characteristics after recycling are:

- density: less than 1.20;
- marsh viscosity: 35 to 90 s;
- sand content: $\leq$ 5%;
- cake thickness: less than 3 mm;
- volume of filtered water: less than 40 cm^3.

The equipment required for the preceeding measurements is to be provided by the Contractor. Tests are to be performed by the Contractor. Tests results are to be listed in the laboratory notebook. Additional tests can be requested by the Engineer.

10.5.2.3 Restrictions to excavation

No excavation will be performed before the set of the nearby strip piles already concreted. Unless otherwise demonstrated by the Contractor, this setting time will be taken as 6 hours.

10.5.2.4 Materials extracted

The materials extracted from the excavation will be transported to the spoil bank.

10.6 CONCRETING

10.6.1 CONCRETE CHARACTERISTICS

This is specified in Section 6. The main required characteristics are:

- Nominal class of concrete: 400/25
- Maximum water/cement ratio: 0.60
- Minimum compression strength 28 days: 24 MPa
- Nominal slump: 16 cm

10.6.2 REINFORCEMENT

Reinforcement will comply with requirements given in Section 8. In addition, the special requirements of DTU 13/2 are to be fulfilled for the minimum steel percentage. The minimum concrete cover will be 7 cm and spacers are to be provided on the reinforcement.

10.6.3 CLEANING OF THE EXCAVATION BEFORE CONCRETING

The bottom of the excavation is to be thoroughly cleaned and the mud recycled or changed before concreting.

The concreting is to be performed in the 3 hours following the cleaning operations.

The sand content of the mud before concreting is to be especially [illegible] will only be performed if the sand content is less than [illegible].

10.6.4 CONCRETING OPERATION

The concreting is to be performed with a concreti.g column whose diameter is larger than 4 times the maximum size of the aggregate. The minimum column diameter is 15 cm. The length of the column is equal to the pile length.

Special care is to be taken at the beginning of concreting to avoid concrete contamination by mud.

During concreting, the minimum embedment of the column in the concrete will be 3 m.

For every strip pile, a concreting curve giving the concrete volume, versus depth of concrete level is to be provided by the Contractor. This curve will be established with at least 5 measurements. A comparison with the theoretical volume is to be performed.

Concreting must be conducted in such a way that, when cutting off pile heads at the required elevation, sound concrete is encountered at least 10 cm above the cut off level.

10.7 CONTROLS

10.7.1 MUD CONTROL

Covered in Chapter 10.5.2.2.

10.7.2 CONCRETE CONTROLS

Covered in Division 6.

10.7.3 CONTROL OF QUALITY AND CONTINUITY OF PILE SHAFT

10.7.3.1 Types of control

Two types of control will be performed :

. Sonic coring test;

. Transient dynamic response test.

These tests are to be performed by a specialist company approved by the Engineer.

The number of tests will be as follows:

. 1 strip pile out of 8: sonic coring;

. 1 strip pile out of 6: transient dynamic response.

For sonic coring, steel pipes inner diameter 50 mm plugged at their lower end are to be installed with the reinforcement before concreting.

The number of pipes will be such that, on each face of the strip pile, the distance between pipes is less than 1.50 m. Sonic coring is to be performed before the pile head cut off.

10.7.3.2 Additional transient dynamic tests

Additional transient dynamic tests may be performed at the reques of the Engineer.

10.7.4 MECHANICAL CORING

In area where anomalies have been detected by the sonic coring or impedance tests, mechanical coring of the concrete will be carried out in 75 mm Ø.

10.7.5 STATIC LOAD TEST

A static load test will be performed at the beginning of the piling works on a strip pile whose section area will be the minimum compatible with the excavation equipment.

Excavation and concreting will be performed with the same method and equipment as those used for the current strip piles. An instrumentation of this pile with extensometer allowing measurements of pile shortening at different depths is to be performed.

The load test will strictly follow the French regulation issued by the Laboratoire Central des Ponts e Chaussées: Essai statique de fondation profonde.

The test layout and the measuring equipment will be subjected to the agreement of the Engineer.

10.8 PILE HEAD CUT OFF

Pile heads cut off is to be performed at el 64.05. Cutting off will eliminate polluted or low strength concrete. The minimum cut off length in sound concrete will be 10 cm.

10.9 DOCUMENTS REQUIRED FROM THE CONTRACTOR

10.9.1 DOCUMENTS REQUIRED FROM THE CONTRACTOR BEFORE THE WORKS

The following documents are to be handed over one month before the beginning of the works.

10.9.1.1 Pile location drawing

This drawing will give at the working platform level for each pile:

- Co-ordinate of pile axis and identification number;
- Absolute elevation of pile head cut off level;
- Absolute elevation of pile tip;
- Loads of first kind;
- Loads of second kind, these loads being reduced at the pile head cut off level;
- Size of strip pile;
- Identification number for reinforcement cage.

10.9.1.2 Technical note

This will give the design calculation for the piles including determination of reinforcement cage and a description of the method and equipment used to perform the works. The earthworks necessary during piling operations are also to be described.

10.9.2 DOCUMENTS REQUIRED FROM THE CONTRACTOR DURING THE WORKS

10.9.2.1 For each pile, a document including the following items is to be submitted to the Engineer:

- Pile identification number and dimensions;
- Time of beginning and end of drilling operations;
- Soil cross section based on observation of excavated soil;
- Drilled length below platform elevation;
- Time of beginning and end of concreting operations;
- Volume versus depth of concrete curve, quality of concrete;
- Incidents observed during drilling or concreting.

10.9.2.2 The results of any informative tests performed by the Contractor will be transmitted to the Engineer.

10.9.2.3 The results and interpretation of the pile load test are to be reported one week after the tests.

10.9.3 COMMUNICATION OF OBSERVATION RESULTS

During the works, the Contractor will keep the Engineer informed about any observation which might modified the initial forecast. More especially, differences between initial site investigation and observations during pile excavation are to be reported. If necessary, modifications to the working method can be proposed by the Contractor.

The contractual implications of these modifications are also to be stated by the Contractor.

10.10 PAYMENT OF QUALITY AND CONTINUITY OF PILE SHAFT TESTS

10.10.1 The controls of quality and continuity of pile shaft are performed at the expenses of the Contractor.

10.10.2 Additional tests defined in § 10.7.3.2 are performed at the expenses of the Contractor if the test results lead to rejection, demolition or refection of the foundation element.

oOo

Division 11

SOIL TREATMENT

11.1 GENERAL

The aim of the soil treatment is to increase the relative density of cohesionless soils in order to achieve a sufficient safety factor against liquefaction under seismic conditions.

11.2 AREAS TO BE TREATED - ELEVATION OF BASE OF TREATMENT

11.2.1 BASIC SOLUTION

The basic solution is:

- Lock itself founded on strip piles (division 10);
- Subsoils around the lock, spillway foundation and closure dyke treated by vibroflotation.

The areas and depths to be treated are shown in drawing NE-07.

11.2.1.1 Lock area

The 5 H to 1 V slope located upstream between the lock and the intake channel of the power house is to be treated between the final lines shown on drawing NE-07 and elevation 52.

11.2.1.2 Spillway

The extent of the treatment under and around the spillway is shown in drawing NE-07.

The elevation of the base of the treatment will be el. 49.

11.2.1.3 Closure dam

The closure dam is to be treated as shown in drawing NE-29. The upper elevation of the treatment is 75. The lower elevation will be such that the upper 6 m of the Nile river bed are treated.

11.2.2 ALTERNATIVES

11.2.2.1 Vibroflotation under the lock: Alternative 1

A complementary site investigation will be performed before the works (see Division 2). If this investigation shows that index properties of the lock foundation subsoils between el. 64 and 52 do correspond to soils which can be successfully improved by vibroflotation, then vibroflotation under the lock itself will be considered as an alternative to strip piles.

11.2.2.2 Heavy tamping: Alternative 2

Heavy tamping will be considered as an alternative to the basic solution. In this alternative, heavy tamping will be performed at all the locations where a soil treatment is required, including the lock itself. Hence in this alternative there will be no strip pile foundation.

The Contractor will have to demonstrate with case histories that the subsoils can be sucessfully treated by heavy tamping.

11.3 REQUIRED RELATIVE DENSITY DR AFTER TREATMENT

The required densities DR to be obtained after treatment are given in the following table. The elevation of the base of the treatment is also given.

The DR requirement applies between the elevations quoted on excavation drawings and elevations of base of treatment given in the table.

Area	For 90% of the controls	Absolute lower bound	El base of treatment
Lock surroundings	DR $\geq$ 75%	70%	52
Spillway	DR $\geq$ 75%	70%	49
Closure dam	DR $\geq$ 75%	70%	Variable: 6 m in Nile river bed
Lock foundation*	DR $\geq$ 75%	70%	52

* Alternative

The relative densities are to be measured at the centres of the treatment grid. If the relative densities measured after treatment in a given area fail to meet the above requirement, then the Contractor will perform to his own expenses a complementary treatment in the area until the specification is met.

The treatment procedure will be optimised to obtain the preceeding requirement. At the spillway location where soils are already locally medium dense, the density of the treatment will not fall below 1 point for 10 m^2 in vibroflotation with a 75 kW probe. In heavy tamping in the spillway area, the applied energy will not fall below 250 $t.m/m^2$.

11.4 CONTROLS

11.4.1 USE OF CPT

As relative densities determination are very cumbersome, static cone penetration tests (CPT) will be used as an indirect measurement of DR.

The basic correlation to be used is that recommended by the Norwegian Geotechnical Institute (NGI) OTC paper 4464 offshore technology conference Houston 1983. This correlation includes a revision of Schmertman test results taking into account further test results obtained since Schmertman's work.

This correlation valid for fine to medium sands can be written:

$$DR\% = \left[\frac{1}{2.91} \ln \frac{qc}{61\ \sigma'v^{0.71}}\right] 100$$

qc tip resistance measured by CPT KN/m^2

$\sigma'v$ Effective overburden pressure KN/m^2

During the trial tests defined in § 11.5, the validity of this correlation for the Esna soil will be checked and amended by the Engineer if necessary, especially when gravels or silty sands are encountered.

As experience has shown that CPT measurements after ground treatment were time dependent due to the sand aging effect, the controls will be performed 7 days after treatment and compared to the requirements of Chapter 11.3. For one control out of 5, a second CPT control will be performed one month after treatment.

CPT tests will be performed according to ASTM standard D 3441 by the Contractor under the supervision of the Engineer.

11.4.2 FREQUENCE OF CONTROLS

. CPTs at 7 days: 1 CPT per 200 m^2

. CPTs at 30 days: 1 CPT per 1,000 m^2

11.4.3 CONTROVERSY ON INTERPRETATION OF TESTS RESULTS

In case of controversy on interpretation of test results with the CPT method, a borehole with undisturbed sampling of the sands and a determination of relative density of the sands according to ASTM 2049 will be performed.

If the tests yield DR value below specification, these testing expenses will be supported by the Contractor.

11.4.4 TESTING EQUIPMENT TO BE PROVIDED BY THE CONTRACTOR

The testing equipment listed in the trial test section is to be present on the site during the whole soil treatment campaign.

11.4.5 IMPLEMENTATION

In order to allow any easy location of areas where the relative density would appear insufficient after the 7 day control, the Contractor will implement and materialise with pegs or any other suitable means profiles at 10 m spacing.

Areas treated and control locations will be located with respect to this reference grid.

11.5 TRIAL TESTS

Trial tests will be performed by the Contractor in order to finalize the selection of equipment and working method. Trial tests are defined in details under the headings vibroflotation and heavy tamping.

11.6 DOCUMENTS REQUIRED FROM THE CONTRACTOR

11.6.1 DOCUMENTS REQUIRED BEFORE THE WORKS

The following documents are required from the Contractor:

- Two weeks before the full scale tests:
  - description of equipment used during the test,
  - method statement;
- Two weeks after the full scale tests:
  - report including observations and measurements performed during the tests,
  - final proposition for method statement in the different areas to be treated.

11.6.2 DOCUMENTS REQUIRED DURING THE WORKS

Every week, the Contractor will issue a progress report showing the area treated, the results of the control and the quantities of backfill used if any.

11.6.3 COMMUNICATION OF OBSERVATION RESULTS

During the works, the Contractor will keep the Engineer informed about any observation which might modified the initial forecast.

More especially, differences between trial test behaviour and observations during current treatment are to be reported. If necessary, modifications to the working method can be proposed by the Contractor.

The contractual implications of these modifications are also to be stated by the Contractor.

11.7 VIBROFLOTATION

11.7.1 COMPACTION METHOD AND EQUIPMENT

11.7.1.1 Vibroprobes

The probe will transmit horizontal vibration to the ground.

It is considered that either 75 kW or 100 kW vibroprobes should be able to satisfy the relative density requirement depending on the adopted column spacing.

The object of the trial tests is to optimise these elements.

11.7.1.2 Compaction method

The vibroflot will be inserted in the ground by jetting and vibrating to the required depth. Compaction then will begin with vibration only. Backfill will be added down the hole for all compaction works performed in the lock area, under the spillway and under any other concrete structure if requested by Engineer.

The probe will then be withdrawn in 30 cm increments during densification. The period of vibration time for each increment will be of the order of 30 s. If necessary, a repenetration of the already compacted hole will be performed before raising the probe for the next increment.

11.7.1.3 Platform elevation for vibroflotation works

It is generally considered that vibroflotation is of a poor efficiency in the upper 2 m of the treatment. Hence the treatment for concrete structures foundations will be performed from a platform located at least 2 m above the levels of excavations for structures.

In case of non observation of this requirement leading to insufficient relative densities in the specified areas, the Contractor will excavate and recompact the soil volume with vibrating rollers in order to fulfill the relative density specification and there will be no additional payment for these works.

For the closure dam, the elevation of the working platform will be such that densification is effectively obtained in the specified area.

In the method statements, the Contractor will give details on platforms elevation during treatment.

11.7.2 TRIAL TESTS

11.7.2.1 Aim of the trial tests

The aim of the trial test is:

- To establish correlations between cone penetration test (CPT - ASTM D 3441) and relative density measurements determined according to ASTM 2049 and density measurement on undisturbed samples. These correlations will be compared to that enforced in Chapter 4 of this specification. If necessary, CPT/DR correlations will be amended based on these results.

- To optimise the column spacing.

- To select a type of vibroprobe.

- To optimise the probe withdrawal process: increments, time length of increments, necessity or not of repenetrating sand column between each step, observations of amperage during withdrawal.

- To investigate two possible types of backfill namely:
  - sands,
  - sand and gravels.

11.7.2.2 Location of the trial tests

Detailed trial tests are to be performed in the different subsoil conditions encountered on the site:

- Lock surroundings;
- Spillway;
- Closure dam (freshly deposited soil).

- equipment required by ASTM D 2216 method for laboratory determination of water content of soil, rock and soil aggregate mixture,
- 2 balances: one at least 20 kg capacity - sensitivity ± 1 g, one at least 1,000 g capacity - sensitivity ± 0.01 g.

11.7.2.4 Test layout

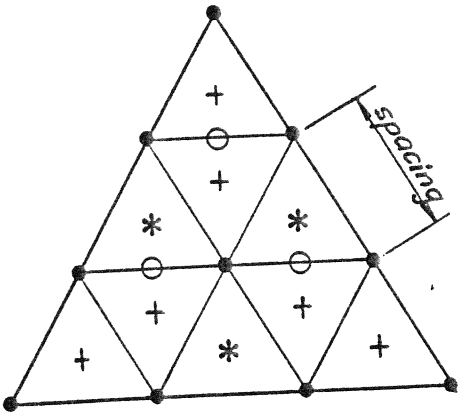
A typical test layout is given in the drawing for a given spacing between centres of vibroflotation.

During the first trial test, three spacings are to be investigated. In the present stage of knowledge of soil conditions, the following spacings should be considered, in association with two types of probes:

Spacing (m)	Probe (kW)
2.00	75
2.40	75 or 100
2.80	100

Based on the Contractors' experience, other combination can be proposed to the agreement of the Engineer before the tests.

The depth to be treated in the tests will depend on the area under consideration. For the closure dam, this depth will reach 20 m.



Legend:

- ● Centre of vibroflotation
- \+ CPT test to be performed 7 days after treatment
- ○ Borehole with continuous sampling and undisturbed samples for laboratory analysis
- ✱ CPT tests to be performed 1 month after treatment

Depth of vibroflotation for the tests under the works: 18 m.

11.7.3 BACKFILL MATERIAL FOR VIBROFLOTATION

11.7.3.1 Sands

The percentage in weight passing sieve n° 200 ASTM will be less than 12%. The material will be taken in temporary stock piles within the site limits.

11.7.3.2 Gravels

They will only be used at the request of the Engineer in order to obtain stone columns acting as relief drains.

The grading will be that specified in 5.4.3 for the coarse transition layer T3. The material will be derived from the pit run gravel.

11.8 HEAVY TAMPING

11.8.1 COMPACTION METHOD AND EQUIPMENT

The soil is to be densified by repeated dropping of heavy weights onto the ground surface.

The weights, the height of drop and the spacing between the impacts is to be adapted in order to obtain the required relative densities.

Special care will be taken in the first passes to avoid creation of a superficial layer of densified materials which could preclude any further successive improvement of underlying soils.

11.8.2 GROUND VIBRATIONS (PPV)

Ground vibrations generated by falling weight impacts will be monitored during the works in order not to induce damages to structures existing or under construction within the site. Damage criteria will be based on peak particle velocity PPV measured with velocity recorder seismographs. The maximum PPV allowable on structure will generally be 50 mm/s. At the request of the Engineer and depending upon observations, this limit can be locally reduced. Measuring and recording equipment are to be provided by the Contractor in sufficient number.

11.8.3 PLATFORM

Elevation of the working platform will be such that the required relative density will be effectively achieved especially in the top part of the treatment area as defined in drawing NE-06.

If the upper part of the treatment area does not fulfil the specification, this upper part will be treated in 30 cm thick layer by conventional compaction with heavy smooth drum vibrating roller at the expenses of the Contractor.

For treatment under concrete structure, and if settlement are such that a backfilling of craters appear to be necessary between different passes, the backfill material will be sand from temporary stock piles.

11.8.4 TRIAL TESTS

11.8.4.1 Aim of the tests

The aim of the tests is to define a working method for the different areas to be treated.

At the end of these tests, the Contractor will have to propose the weights, the height of drop, the spacing between impacts for the different passes, the number of passes and the final required energy per square metre treated. Limitations linked to PPV measurements will be taken into account.

As for vibroflotation, the trial tests will also be devoted to checking the correlations proposed in the specifications between relative density and CPT tip resistance (see 11.7.2.1 first paragraph).

11.8.4.2 Location of the tests

Detailed trial tests are to be performed in the different subsoil conditions encountered on the site:

- Lock surroundings;
- Spillway;
- Closure dam (freshly deposited soil).

The tests will be adapted to the soil thickness to be treated.

11.8.4.3 Required equipment

The specific soil treatment equipment is to be proposed by the Contractor based on his experience for treatment of similar soil thicknesses with similar index properties.

The control equipment (CPT, boring equipment, laboratory equipment) is the same as that required for vibroflotation tests. In addition, velocity recorder seismographs are to be provided by the Contractor for peak particle velocity measurements.

11.8.4.4 Test layout

Detailed test layout will be proposed by the Contractor. The controls during the tests will be performed in terms of tip resistance measured with the CPT. Average settlements after levelling of the craters will also be recorded.

oOo

Division 12

MISCELLANEOUS WORKS

12.1 STEEL PILES FOR MOORING POSTS AND DOLPHINS

12.1.1 STEEL

Steel will conform to API 5 LX grade X 52 yield strength 360 MPa (52 ksi).

12.1.2 GEOMETRY

The steel pile overall diameter OD and wall thickness WT will be as follows:

	OD		WT	
	In	mm	In	mm
Mooring post upstream	30	762	7/8	22.2
Mooring post downstream	30	762	7/8	22.2
Fender	30	762	7/8	22.2
Dolphin upstream	42	1 066	7/8	22.2
Dolphin downstream	30	762	7/8	22.2

An additional length of 0.75 m to the lengths shown on the drawings is to be provided on each pile for cut off allowance to permit the removal of material damaged by the impact of the pile driving hammer and allow pile head levelling.

12.1.3 PILE CONSTRUCTION

The minimum length of a segment of pipe used in fabricating piles should be 1.5 m. The longitudinal seams of two adjacent pile segments should be spaced 90° apart as a minimum.

The welding technique will be adapted to the steel grade of the pile.

The maximum allowable deviation from straightness in any 3 m increment of length should be 3 mm. The maximum allowable deviation in any 12 m increment should be 10 mm. For lengths over 12 m, the maximum allowable deviation should be 13 mm. Corrective action should be taken to prevent additional accumulation of deviation. The metho for checking straightness should be by taut wire along the length of pipe repeated at a minimum of three radius points.

12.1.4 PILE INSTALLATION

. Piles will be installed by straight driving to the penetrations required in drawing NE-14.

The driving equipment will be proposed by the Contractor. The Contractor will produce a detailed calculation note showing that with the pile/hammer combination proposed, the required pile penetrations can be achieved before refusal in terms of blow counts is obtained.

Refusal is defined as follows:

. Either 0.4 mm/blow for 0.25 m penetration;

. or 1 mm/blow for 1.5 m consecutive penetration.

Marks will be painted on piles at 25 cm spacing in order to allow measurements of blow counts during driving. For each pile, the Contractor will give driving records showing blow counts measurements for every 25 cm of driving. The type of hammer used for driving will be indicated; in case of use of diesel hammer driving position will also be mentioned.

. Pile installation tolerances

- for isolated pile:
  - axis: ± 5 cm,
  - out of plumb: 2%,
- for multipile structures
  - Piles will be driven with a temp rary template. Tolerance on template setting in a horizontal plane: ± 10 cm,
  - out of plumb of pile: 2%.

. The Contractor will provide before the works a detailed method statement for pile installation.

12.1.5 STEEL PILES CORROSION PROTECTION

The steel piles shall receive the following corrosion protection in the Manufacturer's factory:

- Sandblasting or other equivalent treatment to achieve a surface finish equivalent to SA 2.5 of Swedish standard S ISO 5 5900 and a surface roughness of 18 fine of the angular scale of Rugotest No. 3 of the LCA.CEA;

- One coast of epoxy zinc blast primer (90% metallic zinc) with a dry film thickness of 15 µ.

On the site the steel piles shall then receive the following final treatment, in a specially designed workshop:

- Whole surface of the steel pile washed with fresh water;

- Blast cleaning of those areas of the blast primer damaged during transport or storage;

- Removal of dust;

- Two coats of pitch/epoxy based paints which must be airless spray applied from a machine in which the two components are stored separately. Each layer must have a minimum dry film thickness between 250 and 300 µ;

- Exposed faces will in addition receive an acrylic resin based coat which will act as a solar screen. This will be applied at the rate of 160 to 200 g per square metre as soon as possible after application of the pitch/epoxy.

12.2 STEEL PILES TO SUPPORT GANGWAYS

Steel piles to support gangways will be 508 mm OD steel pipes (20 in), 12 mm wall thickness (1/2 in). Steel will conform to ASTM A 135 grade B.

An additional length of 0.75 m to the lengths shown on the drawings is to be provided on each pile for cut off allowance and pile head levelling. Dispositions of § 12.1.3 to 12.1.5 apply for pile construction and installation.

12.3 MISCELLANEOUS STEELWORK

Such as railing, ladders, angle reinforcement, chequered cover plate, screen and so forth.

. Metal equipment shall be manufactured as shown on the Drawings or as ordered by the Engineer. No dimension shall be less than specified, but the Contractor might be authorised by the Engineer to overdimension some parts after request.

The work to de done shall comprise the supply of all plant, labour and materials and the performance of all work necessary for supplying and installing miscellaneous steel assemblies or members, including embedded parts and anchors to be incorporated in the works, so grouting and final stage concreting.

. Shop drawings shall be submitted by the Contractor showing complete details, sizes and weights of all steel assemblies, connections, members and supports, including connections to the work of other items, for approval by the Engineer. Work under this subsection shall not be erected until the shop drawings have been approved.

Connections shall be welded possible. All welding which is exposed when the assembly is erected in place shall be ground off smooth.

. Steel work shall be set and adjusted so that after erection and concreting the faces are true to dimension, square, plumb and level within the following tolerances:

- dimension $\pm$ 3 mm,

- plumb and level:

  - 3 mm over 1.5 m,
  - 6 mm over the whole length.

. Painting shall be as specified in paragraph 12.4.

12.4 PAINTING METALWORK

12.4.1 GENERAL

- All painting required to be performed under these Specifications shall be done in accordance with the applicable requirements herein set forth, including the surface preparation, mixing and applying the paint, and the protection of the completed work until accepted by the Employer. The stipulations and requirements herein set forth shall apply to all items of equipment and metalwork to be painted unless specifically modified by the Engineer for any particular item of work.

- The Contractor shall furnish and apply all materials for cleaning, painting, coating and protecting gates, frames, hoists, structural steel, miscellaneous metalwork and all other equipment and materials as herein specified.

- The Contractor shall repair at his own expense all damaged or defective areas of shop-painted equipment and metalwork. Metal surfaces against which concrete is to be placed will be furnished shop-painted and shall be cleaned prior to being embedded in concrete. Galvanised surfaces and non-ferrous metallic surfaces will not require painting except where such surfaces are specifically noted to be painted.

12.4.2 SURFACE PREPARATION

All oil, grease, dirt and rust-preventive compound shall be removed from the surfaces by the use of a suitable solvent and clean wiping material. Following the solvent cleaning, surfaces to be painted, including the damaged areas of shop-painted surfaces, shall be cleaned of all rust, loose mill scale, dirt and other foreign substances by scraping, chipping, blasting, wire brushing, or other effective means, except shop-painted metal surfaces against which concrete will be placed which must be cleaned to base metal by sandblasting or gritblasting. In the event that rust forms, or the surfaces become otherwise contaminated in the interval between cleaning and painting, recleaning will be required. Surfaces adjacent to metal work being cleaned or painted shall be protected by effective masking, or other suitable means, during the cleaning and painting operations.

12.4.3 SHOP-PAINT

Metal surfaces which have been shop-painted shall be handled with care so as to preserve the shop-paint in the best practicable condition. All areas of the shop-paint which are defective or have been damaged shall be cleaned to base metal and repainted before proceeding with any painting operation. Paint applied to such areas shall be of the same type as used for the original shop-paint.

All paint materials shall be approved by the Engineer, prior to precurement. The paint shall not settle or separate within six months after delivery to the extent that it cannot easily be restored to a smooth homogeneous mixture by manual stirring.

12.4.4 APPLICATION PROCEDURES

All paint and coating materials shall be in a thoroughly mixed condition at the time of application. If necessary, to improve application properties, cold applied paints may be heated by means of a hot-water bath to temperatures not exceeding 40°C. Paint shall not be applied when the temperature of the metal, or of the surrounding air, is below 5°C. Surfaces shall be free from moisture at the time of painting. The first coat of paint shall be applied immediately after cleaning. All priming paint shall be applied by brushing. When paint is applied by spraying, suitable means shall be provided to prevent segregation of the paint in the container during the painting operations. Effective means shall be provided for removing all free oil and moisture from the air-supply lines of all spraying and dust-cleaning equipment. Each coat of paint shall completely cover the surfaces and shall be free from runs, sags and blisters. Each coat shall be allowed to dry or harden thoroughly before the succeeding coat is applied. Surfaces to be painted which will be inaccessible after installation, shall be completely painted prior to installation.

12.4.5 PROTECTION OF OTHER METAL EQUIPMENT

Steel surfaces shall be treated as follows:

- Sand blasting to SA 2 1/2;
- Two 40-micron thick coats of zinc chromate glycerophtallic prir r;
- Two 40-micron thick coats of glycerophtallic paint (colour sandy yellow 'yellow arizona').

The specified thickness is the dry thickness.

12.5 PIPES

12.5.1 CONCRETE PIPES

. These pipes supplied by the Contractor shall comply with the requirements of ASTM C 14: class 2 non-reinforced concrete pipes for pipes of diameter 600 mm or less and ASTM C 76: class 2 reinforced concrete pipes for diameters of more than 600 mm.

In addition to the specification of ASTM C 14, the minimum thickness of the pipe wall shall be one ninth of the inside diameter and the minimum strength (three edg bearing method) 10 + 0.6 D kilo Newtons per linear metre (with D inside diameter in centimetres).

. Jointing will be of 2 types:

- Rigid joint: A tarred rope or yarn shall be inserted to one quarter of the total depth of the bell with a wooden tool then the bell shall be completely filled with a 1:2 cement - sand mortar;

- Flexible joints: shall be provided at the junction with concrete structures. They shall be such as to produce a water-tight joint up to a deflection of 2 percent under an internal 5-metre head of water.

All joints shall be of the bell and spigot type.

12.5.2 TOLERANCE FOR LAYING

. Variation from the location or from the level indicated on the Drawings: ten centimetres.

. Departure from or return to alignment: a quarter of the cubic root of the length in centimetres.

. Departure from or return to grade: a sixth of the cubic root of the length in centimetres, but for any unit pipe the slope shall not be less than eighty percent of the slope indicated on the Drawings.

12.5.3 ANCHOR BLOCKS

Any part of the pressure pipes under horizontal forces such as tees, bends, reductions, obturation plates, etc. are to be maintained securely by anchor blocks. The size will be as shown on the Drawings or directed by the Engineer in accordance with the instructions of the pipe Manufacturer.

12.5.4 CUTTING OF PREFABRICATED ELEMENTS

Pipes are to be laid in full length elements. The cutting of prefabricated elements will be done only in case of site necessity and with the prior approval of the Engineer.

12.5.5 SPECIAL ELEMENTS

The connection of pipes with concrete structures will be realised by the means of a manhole coupling embedded in the concrete and a short length sleeve, which shall be one meter or 1.25 dia. long whichever is greater.

12.6 FENCING

Fencing shall consist of a galvanised wire mesh, wire lined and barbed at the top and supported by posts made of steel section, all as shown on the drawings.

Post shall be painted with a red lead primer coat and two coats of glycerophtalic paint, with their lower end grouted into concrete blocks or structures.

One access gate with padlock shall be provided in fencing at each hydraulic control structure.

12.7 UNWOVEN FABRIC FILTER

An unwoven fabric filter will be placed at the location shown on the drawings.

The unwoven fabric filter shall be made from continuous filaments of pure polyester.

The specifications shall be as follows:

Characteristics	Standards	Unit	Value	Min/max
Weight	-	g/m^2	320	Minimum
Thickness	-	mm	2.5	Minimum
Strip width	-	m	4	Minimum
Tensile strength	NFG 07 001	kg/cm	18	Minimum
Elongation at break	NFG 07 001	%	50	Minimum
Tear strength	NFG 07 146	kg	20	Minimum
Permeability perpendicular to plane:				
K value under 0.02 bars		cm/s	10^{-1}	Minimum
K value under 1 bar		cm/s	0.5×10^{-1}	Minimum
Effective opening size		µ	90	Maximum

The work includes: supply, laying and all connection.

The Contractor shall take all possible precautions to prevent damage to the sheeting during laying, and before, during and after the placing of the upper filter. Overlapping between stretches shall not be less than 20 cm.

For the closure dam and intake channels outside the cofferdam where the unwoven fabric is to be laid under water, a detailed installation method statement will be given by the Contractor.

12.8 JOINT SEALING COMPOUND

Installation of sealants shall be in accordance with ACI Manual of concrete practice, part 3 (504-32).

12.9 JOINT COVERSTRIPS

Indoor wall, floor, ceiling and bridge sidewalk shall be covered with extruded aluminium joint coverstrips.

The joint coverstrips shall allow, without any damage, a light traffic as motorcycle, light forklift and so forth.

12.10 BRIDGE DECK EXPANSION JOINT SYSTEM

12.10.1 LIGHT TYPE

This kind of expansion joint is defined in drawing NE-36.

12.10.2 HEAVY TYPE

This kind of expansion joint shall be used for bridge span and pier connection, it shall allow an expansion of 1 centimetre (drawing NE-36).

12.11 RUBBER DOCK FENDERS

They will be supplied by an approved Manufacturer. The required main characteristics are:

- Type: cylindrical
- Length: 2000 mm
- Outside diameter: 1500 mm
- Inner diameter: 750 mm

Rubber characteristics will be such that with the hereabove geometry energy absorption at 50% deformation is 30 t.m.

12.12 FOOTBRIDGE

A steel footbridge is to be built in order to allow a permanent crossing of the lock of the present Esna dam.

The required characteristics are:

- Width: 2.50 m;
- Required air clearance above the 79.00 water level: 10 m;
- Live load: 500 kg/m^2.

The design will be performed by the Contractor and subject to the agreement of the Engineer.

Painting will be performed as specified in § 12.4.

12.13 MONITORING EQUIPMENT

12.13.1 GENERAL

The Contractor shall supply and install all necessary equipment and works in connection with the following measurements and control installations:

- Structure settlements;
- Piezometers;
- Upstream and downstream river water levels.

The Contractor shall place all instruments to the lines and elevations shown on the drawing or as established by the Engineer as work progresses during construction.

The Contractor shall be solely responsible for protection of the installations from damage or displacement until acceptance of all work under this contract. No traffic or equipment shall be allowed to pass over any part of the measurement and control installations. Any damage to an installation shall be repaired by and at the expense of the Contractor.

The Contractor is obliged to perform all necessary surveys in connection with levelling of settlement marks. Immediately after fixing above mentioned control installations, Contractor shall start and shall continue during construction and maintenance periods to monitor structure, groundwater table and river water level changes.

12.13.2 SETTLEMENT MARKS

Settlement marks will be installed at location shown in drawing NE-37.

A mark will be constructed of a 20 millimetres diameter stainless rod, 150 millimetres long with a hemispheric head at its top. The rod shall be set into the concrete with epoxy resin mortar. The hemispheric head shall protrude 15 millimetres above the concrete face.

In addition to the marks shown on drawing NE-37, the Contractor will install settlement marks on the rafts of the power house, spillway and lock. These marks will be installed immediately after concreting of the rafts in order to follow the settlements during construction. The number of marks to be installed is the same as required on drawing NE-37 for the concrete structures.

The Contractor will survey these marks during the construction works.

12.13.3 SETTLEMENT MONUMENTS

The monuments shall be built as shown on drawing NE-37.

12.13.4 PIEZOMETERS

The piezometers shall be located and built as shown on the drawing NE-37.

The piezometers required in § 3.2.4 to monitor water level in the excavation are not shown on this drawing.

12.13.5 UPSTREAM AND DOWNSTREAM WATER LEVEL MEASUREMENT

Four shelters for the water level measurement systems shall be built, two upstream and two downstream the barrage.

The civil work associated with the water level measurement system shall include the following:

. Shelter of pneumatic level recorder:

The internal dimension of the shelter shall be 2.00 m long, 2.00 m wide and 2.30 high.

The shelter shall be constituted as follows:

- a reinforced concrete floor on footings, the finish upper floor level being 15 cm above the inal embankment level;
- brick walls cement rendered on both sides, overall thickness 15 cm;

- a reinforced concrete roof pr..ruding 20 cm around the walls, the roof shall be diamond shape type;

- a vent hole 20 cm wide, 15 cm high located just below the roof on the opposite side of the door including wire net protection;

- a painted metallic door and frames with outward opening located on the smallest dimension; the door lower part shall be equipped in such manner to ventilate the room; the door shall be equipped of lock.

. Pressure tapping protection and support:

It shall be constituted as follows:

- two steel pipe sheaths, internal diameter 70 mm, embedded in the transition layer on the embankment;

- a concrete block 1.50 long, 1.00 wide and 1.25 high crossed by the steel pipe sheaths; all necessary fittings shall be provided to settle the air outlet; the concrete block can be prefabricated or cast under the water level.

12.14 CARRIER MOUNTED HYDRAULIC CRANE

12.14.1 GENERAL

The carrier mounted hydraulic crane will be devoted to the handling of lock stoplogs.

12.4.2 REQUIRED MAIN CHARACTERISTICS

. Type of equipment: carrier mounted hydraulic crane;

. 360° lifting capacity on ontriggers at 75%: 20 000 kg at 15 m radius;

. Maximum axle load: 12 000 kg.

The Contractor will propose a com ercially available equipment fulfilling the main characteristics required hereabove. The detailed technical characteristics of the equipment proposed by the Contractor will be sumitted to the Engineer for approval.

12.15 PITCHED STONEWORK (Hammered)

Pitched stonework construction (hammered) is needed for the navigation lock wall facing, the specification, dimensions and drawings of which are to be submitted by the Contractor for the Engineer and the Employer's approval prior to work in the concerned parts, the quantities, rates and prices of same shall be included in BQ-28.

oOo

Division 13

BUILDINGS

المباني

1 GENERAL

1.1 Previous divisions of the present specifications apply to the buildings (houses, office, laboratory) and/or power plant offices unless otherwise amended by this section.

1.2 The works shall be carried out by approved specialists and shall be of the best standard in Egypt.

1.3 The attention of the Contractor is drawn to the quality of cocks, fittings, locksmithery, etc. which shall be of heavy duty type.

1.4 Provisional water and electricity supplies shall be provided by the Contractor if not available.

1.5 The Contractor is at liberty to propose to the approval of the Engineer any modification to the design of the houses in order to shorten the time of construction provided that the modification does not alter the standard of the building.

13.1.6 DRAWINGS

The drawings show the general arrangement of the buildings; however, where local conditions necessitate a rearrangement, the Contractor shall prepare, and submit for approval, drawings of the proposed rearrangement. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required to supply buildings in convenient condition ready for normal use.

13.1.7 SHOP DRAWINGS, SAMPLES

Shop drawings of buildings and the surroundings of buildings for each type of works (structural elements, joinery water supply, drainage work, etc.) shall be submitted to the Engineer for approval. Material shall not be fabricated or delivered to the site before approved shop drawings have been returned to the Contractor.

As soon as practicable the Contractor shall submit for approval by the Engineer a complete list of materials, fixtures and equipment to be incorporated in the work, together with the names and addresses of the Manufacturers and, when practicable, samples.

13.2 WALLING

Exterior walls, walls and partition walls

a) Cross walls and partition walls shall be built with bricks. The cross walls, the partition walls and the exterior walls shall bind together, thanks to reservation made at their building up if not built at the same time.

Partition walls shall link with the concrete pillars or wall thanks to a 1.5 cm deep groove provided in the concrete. Width of groove shall be in accordance with the thickness of the partition. In addition wall tie 3 Nos per metre shall be provided.

b) The walls shall be rendered on both sides.

c) The first course of the brick walls shall lay on a bitumen felt damp-proof course. Bitumen-felt shall be laid on an even bed of cement mortar primed with hot bitumen. This felt shall be doubled at the connection with the damp proof membrane laid on the floor; angle shall be rounded three centimetre radius minimum.

d) When the walls have projections or recesses at their tops, the brick which is visible on the front shall be visible as well on the thickness; so the vertical joints become horizontal joints.

For some windows the brick wall shall make an angle whose interior side shall be as long as the difference of the thickness between the two walls.

The lintel made of reinforced concrete shall be as thick as the uncoated wall.

When carrying out, the courses of bricks shall be laid at the bottom and on the side of the concrete forming as high as the lintel.

Concrete structure and elements shall be tied with galvanised butterly 4 mm wire wall tie four Nos per metre.

3 BRICKWORK

3.1 FACING BRICKS

Bricks to be used for either external or internal facing shall be carefully selected from the stock.

3.2 MORTAR

Except as otherwise provided mortar for brickwork shall be 400 kg per cubic metre cement/sand mortar. It shall be mixed in a similar manner to concrete. In no case shall a longer time than 30 mn elapse between the first wetting of the mortar and its completed use upon the work. If mixed by hand no single mixing shall exceed one fourth of a cubic metre.

13.3.3 LAYING BRICKS

a) Brickwork shall be of solid construction accurately set to the shapes, dimensions and thicknesses specified.

b) Brickwork shall be built in english bond except for 12 cm thick walls which shall be built in stretcher bond. Brickwork shall be uniform, measuring 11 courses to the metre.

c) Bricks shall be moistened with water from three to four hours before use and shall be kept damp while brickwork's being built.

d) Brickwork shall be fully and carefully bedded, all vertical and horizontal joints being completely filled with mortar. No half bricks or bits are to be used except where closures are necessary.

e) The brickwork shall be carried up in a uniform manner, no one section being raised more than 1 m above another section. Every third course shall be truly levelled and laid fair and level by line and all quoins, perpends, etc. accurately kept true and square, the whole brickwork being properly bonded together in a first class manner.

f) All joints shall be raked out before the mortar is set to a depth of 1 cm for subsequent pointing.

13.3.4 POINTING TO BRICKWORK

a) Pointing shall be done with 500 kg per cubic metre cement sand mortar. Brickwork shall be thoroughly wetted before pointing begins. The mortar shall be well driven into the joints and finished with an approved pointing tool. The brickwork shall be kept wet while pointing is being done and in hot weather the pointed brickwork shall be protected from the sun and cured by water curing or other acceptable methods for at least 10 days.

b) After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workman-like condition.

3.5 REPAIRING BRICKWORK

If after completion of any brickwork, brick is out of alignment or not level, or does not conform to the lines and grades shown on the drawings, or shows a defective surface, it shall be removed and replaced at the Contractor's own expense.

4 WATERPROOFING AND ROOFING

The terraced roofs shall be waterproofed by means of watertight layers and treated as specified hereinafter.

4.1 RAISING

In order to carry out the raisings of the watertight layers a 20 cm high reservation measured from the final level of the roof shall be done in the lower part of the inside faces of the parapet walls and all around the projections of the flatroofs (stacks of smoke pipes, ventilation, air coolers, etc.).

When the watertight layers have been installed, the raisings of these watertight layers shall be covered with a wire netting 3 mm dia. at 5 cm intervals or equivalent reinforcement, and cement mortar in order to protect them.

4.2 HEAT INSULATION

Before carrying out of the watertightness works a thermal insulation shall be worked out with 5 cm polystyrene foam, laid on a vapour barrier of 2/10 mm thick PVC sheet. Slabs of polystyrene foam shall be carefully placed without any gap, broken slabs will not be allowed.

4.3 SCREED

A concrete screed shall be provided to obtain a 1.5% slope of the roof. The concrete screed shall be reinforced at 0.2%.

The screed shall be 5 cm thick minimum and placed over the heat insulation. Concrete shall be spread carefully; a heavy building paper sheet shall be intercalated between the concrete and the insulation in order to protect the insulation. Concrete shall be class 300/15.

13.4.4 WATERPROOFING

The waterproofing shall be constituted of three layers of bitumen felt bonded with hot bitumen.

The process will consist of:

- Penetration layer of quick drying bituminous solution or emulsion 0.3 kg/m^2;
- Bitumen felt;
- Hot coating of bitumen 1.5 kg/m^2;
- Bitumen felt;
- Hot coating of bitumen 1.5 kg/m^2;
- Bitumen felt;
- Hot coating of bitumen 1.5 kg/m^2.

13.4.5 RAIN-WATER DOWN PIPES

Drainage of rain-water will be either through outside down pipes, or down pipes embedded in concrete column or prefabricated gargoyle as shown on the drawing.

Down pipes shall be PVC pipe 125 mm diameter. A strainer shall be provided to avoid solid substances to go through. At right angles with the emptying of rain-water a lead plate 40 cm x 40 cm welded to a pipe 30 cm long connecting the down pipe shall be provided. This plate shall be situated between two coats of bitumen felt.

When the rain-water down pipes are outside the building a lead plate shall be provided on the whole thickness of the wall in order to pipe the waters down to a water zinc box situated outside and fixed on the front of the buildings. From this box the rain-water down pipe shall be laid and fixed on the wall by removable pipe collars of galvanised steel.

Rain-water down pipes shall be connected by means of pit closed with cast iron cover to the general rain-water drainage system.

The Contractor shall submit drainage general layout to the approval of the Engineer.

RENDERING

a) The mixes for rendering shall be:

Treatment	Mix (parts by volume)		
	Cement	Lime	Sand
Exterior	1	1	5
Interior under coat	1	1	6
Rough cast finish	1	2	9
Smooth finish	1	4	8

b) No render which has set shall be used or retempered with water.

c) Brick work shall be brushed and joints raked out for a depth of 10 mm minimum.

d) Outside rendering shall be 15 mm minimum of uniform thickness applied in one coat.

e) Inside rendering shall be 20 mm thick; 15 mm under coat and 5 mm finishing coat.

f) Rendering during the dryest period of the year (15th of May, 15th of September) shall be done only after approval of the Engineer who may require special protection during and after rendering.

g) Rendering shall not be carried out under rain.

FLOOR FINISHING

~~The inside floor level for the one storey houses should not be less than 1.5 m higher than the outside ground level.~~

Floor finishing as shown on the drawings shall be of the following type:

13.6.1 FLOATED CONCRETE

Floated concrete to be painted or not shall be finished in accordance with clause II-6-20b.

13.6.2 TERRAZZO LINING

Terrazzo lining shall have a minimum thickness of 3 cm and shall be made from white cement and selected approved aggregates. The surface of cement shall not be more than one fifth of the total surface.

Wet grinding shall be started after the surface has hardened sufficiently to prevent dislodgment of aggregates. Machines used should be of approved types. During grinding process the depth of exposure must be checked by removing the cuttings with clean water and soft brush. After the first grinding the surface shall be washed and 24 hours after all air holes and blemishes in the surface shall be stopped and filled with a fine mortar consisting of cement and similar sand but having passed through a 0.6 mm sieve in a similar proportion as the concrete or mortar. When the fillings have hardened for 7 days the surface shall receive a second grinding with a medium carborundum stone. Terrazzo shall receive a final grinding and polishing with a fine carborundum stone when the building is ready to be cleaned down.

The lining shall be cured up during seven days after pouring. Cement ratio shall be 500 kg per cubic metre of sand. The terrazzo lining proposed by the Contractor will be submit to the approval of the Engineer.

13.6.3 PRECAST TERRAZZO TILING

Precast terrazzo tiling shall be manufactured under pressing machine at a minimum pressure of 60 bars. The total thickness shall be 25 mm and the terrazzo facing shall be at least 6 mm thick. Manufactured shall be as for terrazzo lining. Second and third grinding and polishing shall be done after laying of the tiles.

13.6.4 LAYING OF TERRAZZO TILES

Flags, tiles and skirting shall be laid on a 2.5 cm thick mortar bed constituted of 200 kg of cement, 200 kg of lime per cubic metre of sand 0/3.

Joints one to two millimetres thick shall be painted with white cement. Skirting joints shall coincide with floor joint.

TOLERANCE

a) Flags and tiles:

Length and width plus or minus	0.5 mm
Thickness plus or minus	2.5 mm
Out of square	0.5 mm
Straightness	1 over 500

b) Laying:

. Straightness of the surface:

- local irregularities: not appreciable,
- gradual irregularities with a 2 metre rule: 2 mm.

. Straightness of the joint:

- local irregularities: 1 mm,
- gradual irregularities with a 2 metre rule: 1.5 mm.

TERRAZZO STAIRS

Terrazzo stair shall be made of reinforced concrete steps six centimetres thick. All visible face shall be terrazzo finished.

Countermarch shall be three centimetres thick.

Landing shall be terrazzo lined.

SILL FOR DOORS AND WINDOWS

Sill windows shall be fitted with prefabricated window boards made of reinforced concrete 6 cm thick fixed in an approved manner.

Sill for doors when shown on the drawings will be fitted with prefabricated sills made of reinforced concrete 6 cm thick.

All visible faces shall be terrazzo lined.

13.7 GLAZED TILES FACING

White glazed tiles (15 x 15) facing shall be laid on draught board 2 m high and on all the perimetre of the rooms except location of cupboard in the following rooms: bathrooms, shower room, wash basin rooms, W.C., kitchens and pantry.

The glazed tiles shall be soaked until saturation and all surplus water shall be drained off before bedding. Angles, edges of wall-linings shall be carried out with one or two round edge glazed tiles.

The adherence of the tiles shall be on the complete surface, the mortar flowing out of the joints. Joints 1 mm thick shall be pointed with white cement 24 hours after placing.

Laying shall be such that the irregularities along the joints shall not exceed 0.5 mm and the tolerances of the finished surface variation from the plumb: 1 cm.

The tolerance of the wall before any rendering shall be:

- variation from the plumb: 1 cm,
- variation from the square between two walls: 5 mm for 2 m with a maximum of 2 cm,
- gradual irregularities with a 2 m rule: 2 cm.

All edges shall be very straight and slightly rounded.

Where differential movement is likely to take place a layer of expanded metal mesh 30 cm wide shall be fixed on the masonry with masonry nails.

Particularly exposed edges in corridor and stairs case shall be protected up to 1.5 m high by special metallic protection.

Tolerance:

- Irregularities with a 2 m rule: 2.5 mm;
- Irregularities with a 20 cm rule: 1.5 mm;
- Variation from the plumb: 1 cm for 3 m with a maximum of 2 cm.

13.8 WOODWORK AND JOINERY

13.8.1 GENERAL

a) Timber used in the works shall be of the best quality of its respective kind available in Egypt, thoroughly seasoned and matured, sawn square, sound straight and fine grain, free from sap shakes, large or loose knots, worm holes, wanes, cracks or other defects.

b) The arrangement, jointing and fixing of all joinery work shall be such that shrinkage in any part or any direction shall not impair the strength and appearance of the finished work and shall not cause damage to continuous materials or structures.

c) Glued joints shall be used where provision need not be made for shrinkage or other movements in the connections. All glued joints shall be cross-tongued. The used of nails for fixing any items of joinery will not be permitted. All screws and bolts shall be countersunk and puttied on and all sprigs shall be punched and puttied.

13.8.2 INTERNAL DOORS

The frames shall be constructed with 10 cm x 8 cm teak wood and shall be sealed in the masonry by binding-irons. The opening leaves shall be made of Swedish white wood veneered with teak wood on both sides and on the edge, and shall be provided with three steel hinges and one Yale inside lock with two keys and handles selected by the Engineer.

As for folding-doors, the semi fixed leaf shall be provided with two bolts one at the top and one at the bottom part of the door.

13.8.3 ENTRANCE DOORS OF HOUSES AND OFFICE

The entrance doors of the houses shall be carried out as follows:

- The frames shall be constructed as for internal doors;
- The opening leaves shall be made of teak timber 4 cm finished thickness.

13.8.4 KITCHEN CABINET

Wall and base cabinet shall be provided in kitchens. Frame members shall be dried hardwood, mortised and tenoned and glued. Doors shall be constructed of plywood lined with formica on both sides. Shelves shall be fixed every 30 cm average and shall have hardwood edges. Base cabinet shall be provided with drawers suspended on paraffin treated hardwood. Top, side, back and bottom shall be plywood veneered with formica.

13.8.5 BUILT-IN CUPBOARDS

Built-in cupboards shall be provided in bedrooms. The cupboard shall be 60 cm internal depth, two metre high and of length as shown in with module of 60 cm.

A shelf shall be fitted at 1.80 m height. The cupboard length below the shelf shall be divided in equal part between hanging space and shelf space. A steel rail shall be provided in the hanging space and four shelves shall be provided in the shelf space. One drawer every two shelf space shall be suspended on paraffin-treated hardwood guides or suitable metal guides. Drawers shall have hardwood front. Doors of built in cupboard shall be skeleton framed flush doors veneered with teak wood on both sides.

13.8.6 BUILT-IN OFFICE CUPBOARD AND BOOK-STAND

Built-in office cupboard and book-stand shall be constituted as built-in cupboard. The total front surface will be divided in roughly equal parts between cupboard on the full height and base cabinets with book-stand on them.

13.8.7 SCREED FOR CUPBOARD

All cupboards shall stand on a concrete screed lined with terrazzo tiles and faced with terrazzo baseboards set 5 cm back from the face of the cupboard.

13.9 PLUMBING AND SANITARY FITTINGS

a) Each building shall be connected to the drinking water system.

b) Each building shall be provided with an electric water heater of 200 litres.

Stop cocks shall be fitted in all places where a pipe leaves the wall to connect to the taps on both, wash hand basins, cisterns of water closets, etc.

c) The fittings that shall be worked up according to the indications shown on the drawings are:

- A 1.85 m long bath of enamelled pig with mixing cocks and fittings; with a reversing system for a hand set shower and a stand on the cocks, a waste-plug, a removable siphon and a waste-pipe connected;
- A wash hand basin (60 x 45 cm) fixed on metallic knee brackets provided with mixing cocks and fittings, a drain-cock and a removable siphon;
- A bidet provided with cold and hot water taps, a drain-cock and a removable siphon;
- Shower tray 80 x 80 cm made of enamelled stoneware provided with a screen-plug, a siphon, mixing cocks and fittings and a fixed rose;
- W.C. pan of European type provided with a flushing cistern forming a little back and a plastic double flap-seat;
- W.C. pan of Asian type provided with a mural flushing of 10/12 litres and a small hanging chain to pull;
- Wash hand basin, bidet and W.C. shall be of white vitreous china;
- The sink shall be 150 m long realised in stainless steel 18/10, containing two deep vats and an integral draining board. It shall be provided with mixing cocks and fittings, a swivelling nozzle, two screen-plugs, a plug with a chain and removable trap;
- Urinals shall be of wall mounted bowl type and shall be fitted with self flushing tank and trapped outlet.

All these appliances shall be connected to the system of draining pipes.

d) In all the W.C. a brass tap fixed on the wall, 0.50 m high from the floor level shall be supplied fixed and connected to cold water.

e) All wastes from wash hand basins and showers shall be fitted with traps which shall be accessible.

f) A sweep hole with trap and stainless steel strainer flush with the floor shall be provided in sanitary room.

g) Drains from all buildings shall consist of 15 cm dia. pipes. They shall be laid in straight lines and at even gradients of 2.5% minimum. Inspection chambers of precast concrete with cast iron air proof covers shall be provided at all changes of direction or gradient.

h) The waste water (wash hand basin, shower, etc.) shall be drained off to a bacterial tray or gravel filter; but the cess-water (W.C.) shall be drained off by different pipes into a septic tank connected to the bacterial tray or gravel filter. The septic tank shall have a 5 cm vent pipe extending to the top-most point level of the building.

The total capacity of the septic tank shall not be less than 1.5 cubic metres.

i) Tests:

Water supply shall be tested at 10 bars. Drainage system shall be filled with water to the level of the highest vent stack above the roof. The system shall hold this water for 30 mn without showing a drop greater than 10 cm.

13.10 METAL JOINERY

13.10.1 GENERAL

a) All windows and outside doors shall be designed to support a pressure of 150 kg/m^2.

b) Buckling of openings. Three angles of an opening being maintained fixed, a force of one kilogramme applied upright on the fourth free angle shall not introduce a displacement of this free angle greater than 8 mm.

c) The openings shall support a vertical force of 100 kg at the top edge of the door or windows opposed to the hinges without any permanent deformation.

d) Standard sized doors shall operate under a force of less than 5 daN and opening windows under a force of less than 3 daN.

e) Lock system shall be quick and efficient with the handle at 4 cm free distance from any fixed element.

f) Metallic joinery shall be built from standard sections allowing a dust proof joinery with double elastomer joints.

g) Number of hinges shall be 2.3 and 4 for openings height of 1.00, 1.80 and 2.50 m. Hinges shall be fitted with bronze ring and the male part shall be adjustable.

13.10.2 STEEL WINDOWS

All windows shall be steel windows galvanised after manufacture.

13.10.3 STEEL DOORS

Outside steel doors for laboratory shall be manufactured from steel plates 3 mm thick minimum, flats, angles, channels welded together. Design and welding shall be such that no buckling shall be noticeable.

13.10.4 ROLLER BLINDS

All the window openings of all the different houses and office rooms shall be provided with plasticised cotton cloth roller blinds weighing about 600 grammes per square metre; these roller blinds being there to guard against the sunshine. These roller blinds shall have a heavy metallic bar, another bar to wind up the blinds and two metallic arms being used to wind off. All metallic parts shall be galvanised after manufacture. The winding up and off of the blinds shall be done with a pull rope situated inside the rooms with a locking system scaled in the masonry.

13.10.5 STEEL GATES OF HOUSES

The enclosing walls of the houses shall have an opening in which a steel door shall be fixed as follows:

- Steel frame made of 70 mm x 10 mm flat iron to form the opening leaf;
- Two horizontal cross-rails made of 50 mm x 8 mm flat iron welded on the frame;
- Vertical bars made of 50 mm x 8 mm flat iron welded on the frame and on the horizontal cross-rails;
- Two hooks welded on the frame and sealed in the masonry;
- Plate welded on the frame to receive the lock that will have two handles;
- Sealing in the masonry of two flat-iron that will be abutment stops.

13.10.6 HOUSE BARRIER

House shall be enclosed by barrier built as follows:

- Base of concrete 25 cm thick, 60 cm high, including a raising of 20 cm over the ground;
- A fence consisting of tee-shaped galvanised steel post (40 x 40 x 4) and 3 mm dia. galvanised wire mesh (40 x 40 mm), 1 metal high. The mean space between post shall be 1.50 m;
- Steel gates as specified in § 6 hereabove;
- Masonry wall 7.2 m long, 30 cm thick and 1.40 m high on both sides of the door which will receive two hodes welded on the frame of the door.

13.11 GLAZING

Material

Glass shall be free of air bubbles, cracks and other deficiencies.

a) Plain glass:

Plain glass is the type to be used for windows, doors, etc. unless otherwise indicated or directed. Its minimum thickness shall be 5 mm. It shall be colourless, clear, flat and straight. The breaking strength under flexural load shall be not less than 300 kg/cm^2. It shall withstand 24 hours exposure to hydrochloric acid vapor and subsequent return to open air without impairment of either its transparency clearness, or lustre.

b) Glass for acoustic insulation of the power plant control room and office at level +78.

The glass used on the power plant internal windows of the control room and office at level +78 shall have an acoustic absorption factor of 32 dB over the range 100 to 3200 Hz.

c) Mirror glass:

Mirror glass shall be silvering quality polished plate glass 6 mm thick. Edges shall be polish bevelled.

d) Glazing putty:

Glazing putty shall be of butyl compound.

e) Glazing beads:

Metal glazing beads shall be supplied with the metal frame and shall be screwed on with sunk.

13.12 DECORATING AND PAINTING

13.12.1 GENERAL

a) All fittings, fastenings and the like shall be removed prior to painting and refixed after completion.

b) All surface and rooms shall be kept free from dust (vacuum cleaning during and after painting).

c) Adequate dust sheets shall be kept available during the execution of painting works to afford protection during progress of painting work.

d) The stopping and filling of pin-holes in plasterwork or rendering shall be done with the same material as the plastering or rendering.

e) The works include the supply at the end of the maintenance period of a quantity of paint necessary to cover one tenth of the surface painted in order to allow future repair and retouch.

f) Before undertaking any decorating work the Contractor shall propose to the Engineer the make and provenance of all the different products with a chart of colour range. The attention of the Contractor is drawn to the necessary harmony between the colour of the equipment, floor, wall and ceiling. Sample proof one square metre will be requested before final approval of any decorating work including rendering.

13.12.2 STEEL WORK

Refer to clause II-12-3.

13.12.3 WOOD WORK

The surface of the support shall be cleaned of all foreign matter and brushed.

The surface shall be stopped up with tinted putty.

A priming coat with pure linseed oil shall be applied.

Careful sand-papering.

Two coats of mat glycerophtalic varnish.

This work shall be carried out on all the internal wood-works of all buildings (doors, baseboards, etc.).

13.12.4 CONCRETE

Three types of decorating shall be performed as described hereafter.

a) Direct: the surface shall be rubbed off with wooden block.

b) Smooth acrilic painting for inside. Two coats of lustreless acrilic paint shall be applied.

c) Rough acrilic rendering for outside: one coat of lustreless acrilic primer, then a coating with acrilic rendering shall be applied.

13.12.5 BRICK WORKS

Three types of decorating shall be performed as described hereafter.

a) Glycerophtalic painting (satin like finished) on smooth mortar rendering in kitchens, pantries, bathrooms, shower rooms, all sanitary rooms and toilets. Two coats of satin like paint shall be applied on wall and ceiling.

b) Acrilic painting on mortar rendering in all other rooms such as all rooms fit for habitation, entrance hall, corridors, bedrooms, office rooms, control rooms and the like. Two coats of lustreless acrilic paint shall be applied.

c) Rough acrilic rendering on mortar rendering for all outside surfaces where visible stone is not specified.

13.12.6 CURTAINING

All windows in the habitation rooms of the house shall be provided with draw curtains made of tergal voile netting for the first curtain and velvet or similar for the second one.

Curtain rails shall be placed inside a box made of plywood veneered with teak. The front band shall be 18 cm high and the inside depth 12 cm.

13.12.7 SUSPENDED CEILING

a) The suspended ceiling shall be acoustic tiles by an approved manufacturer and conform to the following requirements:

- Non-combustible.
- Not allow the spread of flames.
- Vermin proof.
- Easily cleaned or redecorated.
- So designed as to allow the easy replacement of panels.
- Provide the following minimum sound absorption coefficients:
  - 0.45 at 500 Hz;
  - 0.70 at 1000 Hz;
  - 0.80 at 4000 Hz.
- Complete with all necessary suspension and stove enamelled both sides to approved colour.

b) The layout of suspended ceilings must ensure that outlets, boxes, lighting fittings and ventilation grilles are accurately located to the details of the electrical and mechanical services.

c) The ceilings must be accurately fixed to line and level. All fixings including hangers and tying wire shall be galvanised and any damage to galvanising shall be made good before the ceiling tiles are fitted.

d) The Contractor shall be responsible for the safety of the suspended ceiling fixings and the Engineer may call for random tests to be carried out on the fixing before the installation is completed. Shot firing into concrete will not normally be accepted.

e) The choice of ceiling shall be approved by the Engineer.

13.13 EXTERIOR ARRANGEMENTS

13.13.1 COVERED CAR PARKS

a) For house:

They shall be as follows:

- 3 reinforced concrete frame structure 20 x 30 cm section (column and beam) with a clear span of 2.75 m and free passage of 2.20 m high at 3 m center to center;
- Covering by reinforced concrete slab with 40 cm high raising. Reinforced concrete shall be as cast with smooth finished face.

b) For laboratory and office:

The covered car park shall be of light metallic structure and shall provide shelter for 12 cars (all together). Uncovered car park shall also be provided for 12 cars.

13.13.2 FENCING

The area of the office and laboratory shall be enclosed by a 2.30 m high fence. The fence generally consist of Tee shaped galvanised steel post (60 x 60 x 6 mm) and 4 mm dia. galvanised wire mesh 2 m high. The upper part of the post shall be inclined 45° outside with three barbed wire at 150 mm spacing. The lower part of the post shall be strengthened with a 60 x 6 mm plate over 60 cm and embedded over 35 cm in a 70 cm deep and 35 cm diameter concrete block. The average space between two posts shall be 3 m.

Access gate 4 m wide and small gate 1 m wide shall be provided.

13.13.3 WATERING

House, laboratory and office areas shall be provided with two watertap per building for watering of the surrounding planting.

The laboratory or office shall be provided with a concrete paved area with water supply for washing of cars.

13.13.4 PLANTING

The Contractor shall be responsible for planting grass, shrubs and trees of the greatest varieties available and well adapted to the climate. Planting shall be done from the very beginning of the construction of the buildings. The Contractor shall be responsible of their watering and protection up to the end of the period of maintenance.

oOo